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A PLEA FOR THE STANDARDIZATION OF TECHNIC IN THE ORAL METHOD OF CHOLECYSTOGRAPHY¹

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IN February, 1924, Graham and Cole (1) published their preliminary report of a new method of examining the gall bladder by means of the roentgen ray. The interest of the entire medical profession was quickly aroused and in the succeeding four years ample proof of the value and dependability of the test has been reported by numerous observers. Practically without exception cholecystography has been enthusiastically welcomed as an important contribution to the diagnosis of gall-bladder disease. Indeed, it has been claimed that it is the "most valuable single laboratory diagnostic method of gall-bladder disease" (2).

Operative confirmation of the roentgen reports have been singularly favorable. Graham, in a survey of the literature, reports (3): "The percentage of correctness in 446 cases of all authors with a diagnosis of pathological gall bladder was 97.8 per cent. The percentage of correctness in 115 cases of all authors with a diagnosis of normal gall bladder was 74 per cent." Kirklin reports (4) that correct cholecystographic diagnoses have been made in 87.3 per cent of 506 cases operated on. Graham reports (5) on 147 gall bladders removed and subjected to microscopic examination: in 143

of the 147 cases the X-ray diagnosis was confirmed (97.28 per cent).

With the exception of Graham's percentages the majority of the above figures are based on the oral method of administering the dye. In numerous communications published within the last two years we have enthusiastically advocated the use of the oral method of cholecystography, and, after an extended experience of over 2,000 cases, we see no reason to reconsider our claims; in fact, as time goes on, we are more and more pleased with the results obtained. The following analysis of 600 cases examined at the Lenox Hill Hospital, New York City, is interesting as showing the reliability of the oral method. Four hundred ninety, or 91 2/3 per cent, showed a gall-bladder shadow, and 110, or 18 1/3 per cent, were "no shadow" cases. Of these 110, 27 were operated on, and in every case pathology was found. Out of these 600 cases, 40 showed gallstones without, and an additional 40 with, the dye. The total number of cases reported pathologic with or without stones reached 327: 69 of these were operated on and in 67 definite gall-bladder pathology was found. These figures are given with a certain amount of reserve, as percentages are so apt to receive caustic criticism and be misinterpreted by those who are manifestly incompetent to pass judgment.

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ADVANTAGES AND METHODS OF GIVING DYE
ORALLY

The oral method, originated by Menees and Robinson (6), and advocated by the senior author, is commended because it has been proven reliable by numerous observers and is the simplest and most natural mode of administration. It is strictly an office procedure and does not in any way endanger the patient or require hospitalization. In fact, the patient may attend to his affairs between the hours devoted to the examination, as there is slight, if any, inconvenience attached to the test. The patient's activity during the examination does not affect the rate of filling, concentrating, or emptying. The dose of tetraiodophenolphthalein is computed individually. As we give it, in plain gelatine capsules transferred from the ampule a few hours before administration, the dye is fresh, unexposed to light and air: it is consequently subject to no deterioration and there is no commercialization in the preparation of the drug. Occasionally segments of the gelatine capsules retaining some of the dye appear on the film; this is about the only objection to the use of the capsules. Recently in selected cases we have been giving the contents of the ampule at one dose in sarsaparilla or root beer. This makes a delightfully palatable drink which contains just enough carbonic acid gas to put a snap in the taste. We are not prepared as yet to recommend this method in all cases. *The use of the pure fresh drug* is insisted upon, as it is the one thing that has kept our percentage of reactions low and our percentage of gallbladder shadows high. We believe much of the condemnation of the oral method is based upon the unsatisfactory use of commercialized preparations, the drug having been allowed to deteriorate from exposure during preparation and before use. We have tried every conceivable route and

method of administration and are satisfied with our original plan. We fail to see any advantage or superiority of any other mode of administration *so far developed*. We are now fully convinced that most of the dye is absorbed through the gastric mucosa. From experimental research we have found that a certain percentage of the soluble sodium salt administered is converted into an insoluble form by the hydrochloric acid in the gastric juice, but there still remains sufficient of the soluble salt to be absorbed by the mucosa and to render the bile opaque. To prevent this reaction as much as possible we administer bicarbonate of soda with the dye and give both at a time when the acidity of the gastric contents is lowest.

REACTIONS FROM DYE

Much has been written concerning the reactions from administration of tetraiodophenolphthalein. Since using the fresh dye from colored ampules the number of serious reactions has been very small. Nausea is the most common complaint, which, with occasional vomiting and diarrhea, constitutes 99 per cent of the reactions encountered. We cannot recall one case in which the reaction has prevented the examination or interfered with ambulatory cases coming to the office.

ROENTGEN TECHNIC

The technic is most exacting and must be thorough if success is expected. The highest technical quality of films must be insisted upon. The contrast and density of the film throughout the examination must be uniform to permit comparison, so that the degree of concentration may be gauged and changes or variations detected.

Compression on a Bucky diaphragm is preferred. The patient is taught to suspend respiration completely during the exposure. Gas tubes of fine focus are preferred, al-

though, if the patient is heavy, a radiator tube may be substituted. Double intensifying screens and films of great contrast are used. Exposures range from 1 to 4 seconds. Films with good soft-tissue detail are essential, in which the liver margin is clearly distinguishable and good kidney outline plainly visible. At least three satisfactory roentgenograms should be made at each examination.

METHOD OF PROCEDURE

The authors believe that standardization of technic in oral cholecystography is as necessary as in any other method of roentgen examination, and suggest that it be based on Boyden's experiments (7) in physiology, in which he has demonstrated in animals that the gall bladder becomes collapsed and empty from one to two and a half hours after a meal containing an abundance of fat. It then slowly fills for about eight to ten hours, full distention occurring about twelve hours after the meal. With starvation, concentration then begins, the maximum point being reached four to five hours later. Repeated observations on humans confirm in every way this sequence of events.

In making a roentgenographic examination of the gall bladder by the oral method the following technic is recommended. The gastro-intestinal tract should be thoroughly cleansed by a mild cathartic, administered the night before the first examination. This *preliminary examination* of the gall bladder before administration of the dye is best made in the afternoon. While it is going on, the 3.5 grams of tetraiodo, the contents of one sealed colored glass ampule in which it is dispensed, is transferred into eight plain gelatine capsules. These capsules, including four 10-grain capsules of bicarbonate of soda, are given to the patient with the following written directions: "At 6 P. M. eat

a meal consisting of soup, creamed chicken or soft boiled eggs, vegetables, bread and butter, and a glass of milk. Commencing at 9:30 P. M., take two capsules of the tetraiodo and one capsule of the bicarbonate of soda with a half-glass of water every fifteen minutes until all the capsules have been taken." The following morning the patient is to have no breakfast and is directed to report at the doctor's office at 9:30 A. M. At this time the *12-hour examination* is made. Starvation is continued and four hours later the *16-hour examination* is performed. Lunch is then allowed, consisting of two soft boiled eggs, two pieces of well buttered toast, and a cup of tea. An hour later the *18-hour examination* follows. An evening meal is permitted and the patient is told to report the following morning for the final observation, the *36-hour examination*. After this, barium is given and the stomach and duodenal bulb, as well as the hepatic flexure, are studied for evidence of adhesions or associated lesions.

The reasons for the above schedule are these: Well calcified calculi may be visualized at the preliminary examination. Shadows seen without the dye and interpreted as due to a gall bladder with thickened walls are sometimes found otherwise when checked by the gall-bladder shadow after the dye. The fatty meal is prescribed the night before the examination so that the gall bladder may be as empty of bile as possible when the tetraiodo is administered. The gall bladder slowly fills with opaque bile during the night, reaching the point of greatest concentration twelve hours after the administration of the dye. Starvation is continued, and four hours later, at the *16-hour examination*, the greatest concentration is present. This is shown by a decrease in size and an increase in density of the gall-bladder shadow. To test the emptying power, a lunch is prescribed similar to the meal of the preceding evening

and the examination made an hour later, the *18-hour examination*, when the gall-bladder shadow should be markedly diminished in size. Many times, as the gall bladder empties, the ducts are distinctly outlined. At the *36-hour examination* the gall-bladder shadow should have completely disappeared. The gall bladder must *fill, concentrate, change in size, and empty* to constitute the normal cycle: any variation, even though slight, warrants suspicion that the functional efficiency is impaired and a probability, therefore, of a pathologic lesion. Kirklin (8) says that it must be remembered that cholecystography is preëminently a test of gall-bladder function rather than a method of depicting actual disease of the gall bladder. Eusterman (9) says: "It is apparent that cholecystography is preëminently a test of gall-bladder function rather than a method of depicting actual disease of the gall bladder." L. G. Cole (10) stated as follows at the 1927 meeting of the American Gastro-enterological Association: "The functional changes in the gall bladder, in my opinion, are synonymous with pathological conditions." Graham (11) mentions: "In the present state of our knowledge cholecystography does little except to suggest the possibility of functional or possible metabolic disturbance of the gall bladder."

PLEA FOR STANDARDIZATION

The necessity for a uniform technic becomes imperative as soon as an attempt is made to interpret the findings in this functional test in terms of pathology. Is it not equally as important to have a routine in cholecystography as in the examination of the gastro-intestinal tract? What roentgenologist would consider two or three films of a stomach a satisfactory examination of the gastro-intestinal tract? Yet one or two films, often of poor technical quality and

exposed at any time or at several irregular intervals without regard to sequence, are frequently submitted to us for interpretation as a Graham test. This is largely due to a lack of standardization in technic, with the result that a proper comparative study of the density of the shadows at the different examinations cannot be made. Greater progress will be made and comparison of results will be facilitated if the technic of oral cholecystography is standardized, *so that a 12- or 16-hour film of the gall bladder will be as universally understood in a discussion as a 6- or 24-hour gastro-intestinal film.*

THE HEALTHY GALL BLADDER CHOLECYSTOGRAPHICALLY

Having established a definite, accepted technic for gall-bladder examination, it is necessary to define what is meant by a gall bladder with a normal function as we see it cholecystographically. The essentials are proper filling as seen twelve hours after the dye; proper concentration as noted four hours later; proper emptying, partial or complete, following a lunch, and a complete disappearance of the shadow thirty-six hours after the administration of the dye.

As compared with the above negative findings, the positive cholecystographic indications of disease of the gall bladder are, in the order of their importance, as follows:

- (1) Cholelithiasis;
- (2) Failure to visualize the gall bladder;
- (3) Deformity of the gall-bladder shadow;
- (4) Faintness of shadow;
- (5) Persistency of the shadow;
- (6) Late appearance of the shadow.

CHOLELITHIASIS

On a cholecystogram, gallstones are of two varieties—opaque and non-opaque. The *opaque* stones have sufficient calcium con-

tent so that their shadow is visible at the preliminary examination on the roentgenograms made before the tetraiodophenolphthalein is given. The *non-opaque* stones are composed mostly of cholesterol and have insufficient calcium content to be visible unless the dye has been given. If a gall-bladder shadow is obtained, the stone appears on the film as a dark spot within the white gall-bladder shadow. Opaque bile surrounds the non-opaque stone and visualizes it by contrast of shadow. A single large stone may be seen in the fundus, or the gall bladder may be partially or completely filled with stones, in which case there is a typical mottling or honeycombing of the white gall-bladder shadow. If no gall-bladder shadow is obtained because the cystic duct is obstructed and dye cannot enter the gall bladder, these stones are not recognizable and the examination is reported as a "no shadow" case. Enough dye may enter the gall bladder to "coat" the stones and render them more easily visible.

Gas in the duodenum or colon may overlie the gall bladder and produce confusing shadows. The way to differentiate is to compare the position of the suspicious shadows on the 12-, 16-, and 18-hour cholecystograms. Gas will change in position during a period of six hours and the dark spots will vary in position on the different films, usually moving outside the gall-bladder outline. If the shadows show no change in position on all of these films, one can be relatively certain that gallstones are present. Of course, the examination may be repeated if doubt still remains. Calculi are especially easy to recognize in the 18-hour films, when the gall bladder is contracted to its smallest size, because at this time the shadows of the stones lie only and entirely within the gall-bladder outline, and the duodenum and colon are least likely to overlie the gall bladder. The detection of non-opaque stones rests almost entirely on repeated ex-

aminations, as suggested, and they will probably be missed if a standard technic is not used. If no preliminary films are made before the dye is given, calcified stones easily seen on these films may be overshadowed with the opaque bile and be overlooked. The gall-bladder wall may be greatly thickened, and, with the opaque bile in addition, will overshadow stones so that they are unrecognizable. *It is a necessity, therefore, to examine both before and after the test, as well as during the filling and emptying of the gall bladder with the opaque bile.*

FAILURE TO VISUALIZE THE GALL BLADDER

A "no shadow" test is one of the most valuable findings, the list of causes for which is changing as our experience widens. Any obstruction to the cystic duct from an intrinsic or extrinsic cause will prevent the opaque bile from entering the gall bladder. The most common cause of obstruction is from a stone in the cystic duct, although, in support of Lyon (12), we have found edema of the wall of the cystic duct sufficient to temporarily prevent entrance of the opaque bile. In many cases we believe this to be the explanation of a shadow absent at one examination which appears on a second examination, the edema being less and permitting the dye to enter. Stricture and atrophy of the duct also prevent visualization. Obliteration of the lumen of the gall bladder, the result of an old chronic inflammation or a gall bladder packed with stones, will act likewise. Impaired liver function, extensive disease of the liver, the conditions producing jaundice, acute abdominal disease of certain types, and many other disease processes may at times prevent gall-bladder visualization. H. S. Plummer (13) adds a group characterized by easy fatigability, achlorhydria, and lowered basal metabolic rate, the so-called asthenic type with "no

shadow" results. Our experience with such cases has been that the emptying is delayed frequently and that the gall bladder is ptosed and large.

If there is an absence of shadow, it is well to confirm the findings by a re-examination, to be sure that it is not due to some fault in the technic. A good 12-hour shadow followed by an absence of shadow at the 16-hour examination is evidence that the patient has broken the fasting period. Many authors recommend the use of the intravenous administration of the dye in making the confirmatory examination. We have not found it necessary. The oral method, in our hands, has proven just as reliable without the disagreeable features of the intravenous. The idea that the shadow following intravenous administration is more dense is fallacious. To those using the oral method, standardization is imperative, so that one may become familiar with the appearance to be expected at the various examinations and able to interpret variations.

DEFORMITY OF THE SHADOW

Deformity of the gall-bladder shadow due to pathology, the most common being adhesions, may be of gall-bladder or omental origin. When they are caused by cholecystitis the shadow is more apt to be deformed and the edges are likely to be roughened and irregular. In a majority of these cases stones are present as well. When caused by omental adhesions the deformity is present, but, as a rule, the edges are clear-cut and the entire outline of the gall bladder quite distinct. While we have seen at the operating table gall bladders embedded in a mass of adhesions which did not produce deformity on the cholecystograms, it is the general rule that such adhesions produce irregularity in outline sufficient to be recognized. Adhesions of pericholecystic origin may involve the duodenum, liver, or colon

without producing deformity. This may be recognized by malposition and fixation of the gall bladder. It is often difficult to differentiate between a deformed gall bladder due to pathology and one due to pressure or posture. The persistency of the same deformity in both the prone and erect positions will assist in the differentiation. Pressure defects are no indication of cholecystitis. As our experience becomes more extended we find a considerable number of cases showing anomalous deformities, in the nature of sacculations, angulations, or inversions. Here the differentiation requires an extra amount of good judgment. Fluoroscopy, when possible, will give added information.

FAINTNESS OF SHADOW

Extensive experience is needed to properly gauge the density that should be obtained in the gall-bladder image and to judge the importance of any variation of the cholecystographic opacity. A perfected and standardized technic which can be absolutely relied upon makes the finding "faintness of shadow" of great importance. Anatomically, an unusually high position of the gall bladder, so that it is up behind the liver, may be the cause of faintness of shadow due to the increased thickness of tissues between the gall bladder and the film. The same cause is present in cases of ascites, obesity, and late pregnancy. Some of the changes responsible for absence of shadow, when present to a lesser degree also act as causes, *e.g.*, a partial obstruction of the cystic duct may permit some opaque material to pass and faintly outline the gall bladder. A thick-walled gall bladder containing stones usually results in faintness of shadow. A disturbance in the concentrating ability of the mucosa of the gall bladder results in faintness of shadow. In this case comparison of the 12-, 16-, and 18-hour films is essential to detect the inability to con-

concentrate the dye. *Our only hope in the detection of early cholecystitis is based on this failure to function.* At twelve hours the gall bladder is fully distended. This shadow normally diminishes slightly in size and becomes intensified or a denser white by the time of the 16-hour examination. If this sequence does not occur, there is inability on the part of the mucosa to concentrate the dye—evidence of impaired function. This is often associated with poor emptying after a meal, as a result of loss of contractability of the wall of the gall bladder. A faint shadow at the 12-hour examination often shows satisfactory and normal intensification at the 16-hour examination, but if the faint 12-hour shadow remains faint at the 16-hour examination and there is no change in the size of the gall bladder, we believe this condition constitutes evidence of poor concentration and lessened elasticity of the wall. In our opinion such a finding is pertinently suggestive of cholecystitis.

PERSISTENCY OF THE SHADOW

When the shadow of the gall bladder does not markedly diminish in size after food, and persists thirty-six hours after administration of the dye, it is usually a fairly reliable indication of an advanced cholecystitis, and we may reasonably conclude that the normal function is interfered with by pathology. This deduction has been repeatedly proven to be correct by the surgical findings in these cases. A general retardation of the entire sequence may be present in asthenic individuals whose general condition prevents the gall bladder from emptying in the normal period. If the 18-hour shadow, obtained one hour after food, is markedly diminished in size when compared with the 16-hour shadow, and then at the 36-hour examination is increased to about the size seen at the 16-hour, the assumption is that re-absorption of the dye

has occurred from the intestine, and the finding is disregarded.

LATE APPEARANCE OF THE SHADOW

This is rather a rare finding, but must be mentioned, for in three of our cases the gall-bladder shadow did not appear until thirty-six hours after the dye had been given. All were proven to be pathologic: the gall-bladder wall was thickened, and, in one, stones were present which had not been recognized by the roentgen examination.

REMARKS ON DIAGNOSIS OF CHOLECYSTITIS AND VALUE OF CHOLECYSTOGRAPHY

The subject of diagnosis of cholecystitis is too large to be more than mentioned at this time excepting in its relation to cholecystography. A certain percentage of gall-bladder cases with typical history and physical findings are diagnosed with ease clinically, and cholecystography is not essential, or, at most, is only confirmatory. On such a series of selected cases very favorable statistics are possible, as to the accuracy of clinical diagnosis compared with operative findings. It is not in this field that the test is of greatest value. Rather, the need for it will be presented by that large group of patients with indefinite and varied abdominal complaints, who are a puzzle to the diagnostician. In fact, careful autopsy studies have clearly proven that many cases of actual gall-bladder pathology are still being treated as "gastritis," "gastric neurosis," or not recognized definitely enough to even secure a label. Mentzer (14) states that in 612 routine postmortems, 66 per cent had evidence of pathology in the gall bladder, while only 8 per cent had had a primary diagnosis of cholecystitis. As Graham (15) brings out, Eusterman, of the Mayo Clinic, states that "the clinical history and physical examination, including

the elimination of the stomach and duodenum as the site of disease by roentgen-ray examination, enable the experienced clinician to make a diagnosis of definite cholecystic disease in more than 90 per cent of the cases." If so, the need for cholecystography would hardly exist. Mentzer, in reporting studies made on material at the Mayo Clinic, states that "clinicians accurately identify a diseased gall bladder in about 85 per cent of the cases." Graham continues: "It seems to us a bit inconsistent, however, that in another paragraph he states that 'of 1,647 consecutive patients examined at necropsy, 37 per cent had cholesterosis of the gall bladder. Gallstones accompanied the lesion in 20 per cent of the cases. Gall-bladder disease was not anticipated in most of these patients, for in 87 per cent of them the history of gastro-intestinal disease had been negative.' In other words, without the use of cholecystography it would seem that even such excellent clinicians as those at the Mayo Clinic really fail to recognize a very large percentage of diseased gall bladders. The proportion of error must be greater in places where the clinical skill of the examining physician is not on the same high plane. It is our opinion that a more extensive use of cholecystography will greatly reduce the high percentage of error which now occurs without this aid. Of course, it is a simple matter to recognize by clinical methods those cases which present classical symptoms and signs, but our aim in diagnosis is ever to increase our ability to recognize the less obvious and the early disturbance. Probably, also, 90 per cent of the cases of carcinoma of the stomach can be recognized by clinical means alone if we wait for the classical signs to appear. But who wishes to advocate that plan?"

Eusterman (16) obtains 30 per cent of false negative reports in definite gall-bladder disease, and some others about the same. Such findings make one question whether

there is not a fault in the technic. Rather, our experience has been similar to that of Graham (17), who believes that with few exceptions "normal cholecystographic behavior eliminates the biliary tract as the offender in a case of differential diagnosis." Sosman (18), of Boston, states: "Contrary to the findings of Dr. Kirklin, a good dense gall-bladder shadow has nearly always been found to indicate a normal gall bladder." There is needed in these discussions, however, more definiteness as to exactly what pathologic changes constitute the diagnosis of cholecystitis.

Criticism of any new method or test is helpful and should be encouraged. Cholecystography is no exception, and when the discussion is ended it will be because its usefulness is a thing of the past. Everyone acknowledges that no laboratory procedure nor clinical judgment, however superior, is infallible. The laboratory at its best is confirmatory and usually helpful to the clinician. Criticism, to be most helpful, must be based on a standardized method, else it will lack pertinency.

DIFFERENTIAL DIAGNOSIS

In the differential diagnosis there are at least three groups which may offer difficulty.

(1) *Duodenal ulcer*.—Eusterman (19), of the Mayo Clinic, claims that in 41 per cent of his "false positives," where "no shadow" tests were obtained, a duodenal ulcer was present at operation and the gall bladder was normal. It is rather remarkable that Kirklin (20), of the same institution, states: "While the gall bladder is believed to be sensitive, its behavior in the cholecystograms as observed in this series (25 cases) is apparently seldom affected by duodenal ulcer, chronic appendicitis, pelvic lesions and many other diseases of the abdominal organs." In our experience, based on intensive and painstaking effort on a smaller amount of material, the findings

have been quite like Kirklin's. Cases with absence of gall-bladder shadow and deformity of the bulb due to ulceration have had both present at operation. Practically without exception duodenal ulceration has not interfered with obtaining normal cholecystograms.

(2) *Sub-acute and chronic appendicitis.*—We have obtained normal cholecystograms in the majority of cases diagnosed as sub-acute and chronic appendicitis. One case of appendiceal abscess, with the appendix and cecum high up near the gall bladder, gave a "no shadow" finding although the gall bladder appeared normal at operation. A double lesion is as a rule accountable for a "no shadow" finding, should the gall bladder be examined as well as the appendix.

(3) *Right urinary tract.*—Right renal calculi are easily differentiated from cholelithiasis by cholecystography. A Graham test is a much less disagreeable procedure for the patient than pyelography, if a differentiation for stone only is desired. The roentgenograms made one hour after a meal are especially valuable in this differentiation, since the normal contracture of the gall bladder as it empties usually separates it from the renal calculus. A lateral view will demonstrate the exact relation of the calcified shadow to the gall bladder. A recent case illustrates the need for thoroughness in these examinations. A patient entered the hospital to be operated on because a Graham test had demonstrated gall-stones. Our examination revealed a calcified shadow on the preliminary films; at the 12- and 16-hour examinations it appeared to be within the gall-bladder shadow. At the 18-hour examination, one hour after food, the gall bladder was contracted as found normally and the calculus was outside and below the gall bladder. On a lateral view the stone was seen to be behind the gall bladder in the kidney region. On pyelography and at operation it was found

to be in the inferior calyx. Mistakes such as this can easily be prevented if a standardized technic is used, combined with care and patience.

REFERENCES

1. GRAHAM, E. A., and COLE, W. H.: Roentgenologic Examination of Gall Bladder: Preliminary Report of a New Method of Utilizing Intravenous Injection of Tetrabromphenolphthalein. *Jour. Am. Med. Assn.*, Feb. 23, 1924, LXXXII, 613.
2. EUSTERMANN, GEORGE B.: Limitations of Cholecystography with which Physicians should be Familiar. *Trans. Am. Gastro-enterological Assn.*, 1927, p. 221.
3. GRAHAM, E. A., COLE, W. H., COPHER, G. H., and MOORE, SHERWOOD: Diseases of the Gall Bladder and Bile Ducts. Lea and Febiger, Philadelphia, 1928, p. 331.
4. KIRKLIN, B. R.: Efficiency and Limitations of Cholecystography. *Boston Med. and Surg. Jour.*, Feb. 9, 1928, CXC VII, 1487.
5. GRAHAM, E. A., COLE, W. H., COPHER, G. H., and MOORE, SHERWOOD: Diseases of the Gall Bladder and Bile Ducts. Lea and Febiger, Philadelphia, 1928, p. 331.
6. MENEES, T. O., and ROBINSON, H. C.: Oral Administration of Sodium Tetrabromphenolphthalein: Preliminary Report. *Am. Jour. Roentgenol. and Rad. Ther.*, April, 1925, XIII, 368.
7. BOYDEN, EDWARD: Behavior of Human Gall Bladder during Fasting and in Response to Food. *Proceedings of the Society for Experimental Biology and Medicine*, 1926, XXIV, 162.
8. KIRKLIN, B. R.: Efficiency and Limitations of Cholecystography. *Boston Med. and Surg. Jour.*, Feb. 9, 1928, CXC VII, 1487.
9. EUSTERMANN, GEORGE B.: Limitations of Cholecystography with which Physicians should be Familiar. *Trans. Am. Gastro-enterological Assn.*, 1927, p. 221.
10. COLE, L. G.: Discussion on Diagnostic Value of Duodenal Drainage in Gallstone Disease by Pierson, G. M., Bockus, H. L., and Shay, Harry. *Trans. Am. Gastro-enterological Assn.*, 1927, p. 249.
11. GRAHAM, E. A., COLE, W. H., COPHER, G. H., and MOORE, SHERWOOD: Diseases of the Gall Bladder and Bile Ducts. Lea and Febiger, Philadelphia, 1928, p. 322.
12. LYON, B. B. VINCENT, and SWALM, WILLIAM A.: Obstruction of the Cystic Duct of a Catarrhal Variety. *Trans. Am. Gastro-enterological Assn.*, 1927, p. 224.
13. PLUMMER, H. S.: Quoted by Kirklin in "Efficiency and Limitations of Cholecystography." *Boston Med. and Surg. Jour.*, Feb. 9, 1928, CXC VII, 1487.
14. MENTZER, S. H.: Status of Gall-bladder Surgery: Based on Study of 14,000 Specimens. *Jour. Am. Med. Assn.*, Feb. 25, 1928, XC, 607.
15. EUSTERMANN, GEORGE B.: Limitations of Cholecystography with which Physicians should be Familiar. *Trans. Am. Gastro-enterological Assn.*, 1927, p. 221.
16. Idem.
17. GRAHAM, E. A., COLE, W. H., COPHER, G. H., and MOORE, SHERWOOD: Diseases of the

- Gall Bladder and Bile Ducts. Lea and Febiger, Philadelphia, 1928, p. 319.
18. SOSMAN, M. C.: Quoted by Kirklin in "Efficiency and Limitations of Cholecystography." *Boston Med. and Surg. Jour.*, Feb. 9, 1928, CXCVII, 1487.
 19. EUSTERMANN, GEORGE B.: Limitations of Cholecystography with which Physicians should be Familiar. *Trans. Am. Gastro-enterological Assn.*, 1927, p. 221.
 20. KIRKLIN, B. R.: The Normal Cholecystographic Response. *RADIOLOGY*, July, 1928, XI, 34.

Measurements Regarding Quality and Intensity of Scattered Radiation. Hans Jacobi and Adolf Liechti. *Strahlentherapie*, 1928, XXVII, 711.

A number of publications dealing with the measurement of the "back-scattering" in roentgen therapy do not show satisfactory agreement, evidently because different qualities of rays and different ionization chambers have been used. The authors have therefore undertaken to establish comparable data which are valuable in practice. Careful consideration was given to the influence of the absorption law (roentgen) and the Compton effect. The measurements have been carried out with all possible precautions. Two ionization chambers were used, which were independent of the wave length. The results are presented in a number of tables and curves which offer a wealth of information. They should be studied in the original. It is interesting to note that paraffin does not seem to be a suitable material for measurements in a phantom.

The amount of "back-scattering" varies with the type of tissue. It is different, for instance, for fields over the sacral, abdominal, or chest region.

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The Use of Amyl Nitrite as an Antispasmodic in the Roentgen Examination of the Gastro-intestinal Tract. George W. Holmes and Richard Dresser. *Am. Jour. Roentgenol. and Rad. Ther.*, January, 1928, XIX, 44.

Amyl nitrite is recommended as an antispasmodic to be preferred over the more commonly used atropine for gastro-intestinal X-ray studies where spasm is encountered. Not all cases of pylorospasm of extrinsic origin are relieved by amyl nitrite, but the authors believe the same criticism may be applied to atropine. The irritable spastic colon was found to be almost invariably relaxed by one or two "pearls" of amyl nitrite.

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BONE DISEASES¹

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WOULD it not clarify the existing confusion if the roentgenologist were to report the complicated bony changes noted in the examination of a case suspected of being osteitis deformans, osteitis fibrosa, osteomalacia or some of the other closely allied bone conditions, by stating that the findings indicate an osteitis?

It is felt that a more comprehensive description of the roentgen findings than simply the statement "osteitis" is necessary. Such descriptions, it seems, should be related to the changes noted on the film describing the arrangement of the bone trabeculae; the presence or absence of cyst formation; periosteal bone production; the bending and deformity of the bone or bones and the presence or absence of arteriosclerosis, also bearing in mind that certain diseases of the bones owe their origin to the action of toxin, which may be of intestinal or bacterial origin, but the metabolism of bone also plays a most important part. Predisposing to the development of fibrous replacement, the osteoporosis and cystic formation which are described as so typical of osteitis fibrosa are also described as being present in osteitis deformans, but the striking increase in bone formation is the characteristic picture. In the third type we have the marked calcium absorption so characteristic of osteomalacia without the fibrous cystic formation or the striking increase in bone formation, noted in the other two conditions.

Idiosyncratic susceptibility on the part of the patient, also the ability of the bone to resist toxic influence, are of great importance in determining the type of bone

change which will be produced. If the vitality is good, the resistance opposed to the toxins may ward off harmful effects until the constitutional strength is reduced by age or intercurrent disease. The reaction in such cases is strong and the resulting effects take the form of osteitis deformans. On the other hand, if the vitality is low, the disease will appear earlier—either in childhood, adolescence, or early maturity. Under these conditions the reaction is only fair, not as vigorous as in osteitis deformans; the form the disease then assumes is osteitis fibrosa cystica.

Lastly, when, owing to a severe depression of the patient's vitality by untoward circumstances, the power to react is absent, the form the disease then assumes is osteomalacia.

An interesting theory in regard to the disturbance of the calcium metabolism is approximately as follows: that this imbalance in the body calcium or the calcium in the blood is the result of a hyperfunctioning of the parathyroids. Whether this disturbance in function of the parathyroids is due to an infection or not, it is impossible to say. The theory goes on to state that the diseased parathyroids cause abnormal metabolism in regard to calcium and that the body is forced to go to its main storehouse of calcium to replenish the supply, the main storehouse being the bones. Consequently, the bones react and the osteogenic tissues proliferate, but the chemical analysis of these diseased bones shows a deficient calcium content.

In one case of the author's, diagnosed as osteomalacia, a parathyroidectomy was attempted, but, as stated in the patient's history, her condition was not sufficiently good

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to stand the operative shock, so no conclusions could be drawn from this.

There is a case on record, a patient in the Russell Sage Department at Bellevue Hospital, that was diagnosed as osteomalacia and the parathyroids were removed. The patient's blood calcium previous to operation was 19.2 milligrams per 100 c.c., which is very high. He made a happy recovery from the operation and is now about, one year later, in good health and the calcium content has returned to normal. He had had numerous pathological fractures and marked absorption of the calcium content of the bones. Since then, he has had no more pathological fractures but we have no X-ray films to show the present appearance of the bones.

It seems that there are no grounds for objection to the use of the term "osteitis," as the authorities seem to agree with fair unanimity that these obscure changes in the bones are of chronic inflammatory nature, but that they probably result more from abnormal metabolism or intestinal toxins. This would differentiate the condition from the acute and chronic forms of osteomyelitis, which, of course, is also the result of inflammation of bone, but in which probably the metabolism of the patient is normal.

Let us attempt to get away from the use of the terms "Paget's disease" and "Von Recklinghausen's disease," and endeavor to simplify our classification, as is being tried out in the classification of bone tumors.

The author feels that osteitis deformans and osteitis fibrosa are the same disease, but that osteitis fibrosa is the manifestation of Paget's disease in the young and that osteitis deformans (Paget's disease) is the reaction of the bones in the adult past middle life. This statement should be qualified to some extent because one must bear in mind that there seem to be two distinct types of osteitis fibrosa cystica, namely, the localized, in which one bone is affected, and the gen-

eral, in which a number of bones are attacked. This latter type is quite rare, there being only four cases in Bloodgood's series of sixty-nine cases of osteitis fibrosa. It is this general type which, it seems probable, is the condition known as Paget's disease. Authorities consider it essentially an inflammatory one, a low grade form of chronic osteomyelitis. This seems especially true in the localized form, as in one case of the author's wherein the condition followed some years after an attack of typhoid fever.

On the other hand, there is evidence, especially in the general form, with the involvement of numerous bones, to suggest that this is one of those obscure disorders of calcium metabolism and ossification of which Paget's disease, osteomalacia, achondroplasia, rickets, and hereditary deforming chondrodysplasia are other examples. There are reported cases in which the typical changes of osteitis deformans, noted both from the X-ray and pathological findings, existed in one bone only. Again, however, these patients have all been past middle life.

But if osteitis fibrosa and osteitis deformans are to be looked upon as simply different expressions of the same disease, determined by the dissimilar resisting powers of their victims, what, then, is the position of osteomalacia?

R. Lawford Knaggs, in his article on Osteitis Deformans in the *British Journal of Surgery*,² states that he believes there is a distinct connection between osteomalacia, osteitis deformans, and osteitis fibrosa and that they probably have an identical origin; just as osteitis fibrosa and osteitis deformans are determined by some inbound property of the individual, so osteomalacia is to be similarly explained. Clinical signs of bending, and fractures of the bones, may be dismissed as of little importance in establishing this relationship, but, if the histo-

²October, 1925, XIII, No. 50.

logical features of the three diseases are contrasted, their significant conception is suggested.

In contrast to osteitis deformans and osteitis fibrosa with osteomalacia, the latter shows the reactionary change in the marrow developed only to a slight extent. In histological sections the dissolving and disintegrating trabeculae may be seen to be surrounded only by narrow bands of newly formed connective tissue, and, outside these zones, tracts of ordinary fat marrow persist. There is no sign of ossification in this tissue but bone disintegration alone is going on. This may be explained by the severe depression of the patient's vitality, which is easily understood if one considers the depressed and enfeebled condition of those patients in whom osteomalacia develops. The majority of these sufferers have been subjected to debilitating influences such as poverty, privation, repeated pregnancies, improper food, and residence in unhealthy, damp localities.

THE CORRELATION OF OSTEITIS DEFORMANS, OSTEITIS FIBROSA, AND OSTEOMALACIA

When describing the histology of osteitis deformans one cannot help but be struck by the close resemblance of the microscopic appearance to that of osteitis fibrosa. The essential characteristics are the same; any differences which can be detected are matters of degree. In considering the relations which exist between osteitis deformans, osteitis fibrosa, and osteomalacia, the pathologic process with which all three are intimately concerned should be constantly borne in mind. The process begins by the entrance of certain toxins into the circulation. These toxins—of metabolic or intestinal origin—are carried by the vessels to the bones and diffused by the lymph. The effect produced on the different constituents of bone varies. The osseous framework, be-

ing a more vulnerable tissue than the marrow, has its vitality depressed beyond its power of recovery, but the connective-tissue basis of the marrow is excited to remarkable activity. The reaction which the toxic injury originates is shown by the striking alteration in the marrow. It is changed into an actively growing, vascular connective tissue, whilst the fat vanishes from the cells, or the fat cells themselves disappear. This new tissue plays a twofold part: (1) through its agency the damaged bone breaks up and disappears; (2) it becomes busily engaged in the manufacture of fresh bone by the metaplasia of its own fibrils and cells.

It should be noted that resorption, even of the new bone, is always going on, and sometimes is so widespread and active as to suggest a continuous action of the toxins. At one time the reactionary soft tissue in the bone is probably largely in excess of the contemporary bony framework; but ossification, especially in osteitis deformans, outruns resorption. Howship's lacunae and lacunar spaces, formed by the coalescence of trabeculae, are speedily filled with new bone, and rows of osteoblasts are now seen behaving normally. In this way the bone may be reconstituted.

There are certain peculiar features of this reaction in the case of osteitis deformans which seem to indicate that the bones in this disease are less seriously affected by the toxins than they are in osteitis fibrosa. These peculiar features are: (1) the original bone is often not so completely removed as in osteitis fibrosa; (2) the reaction is apt to extend not so deeply into the fat marrow (the persistence of the central cavity in the long bones may be taken as an evidence of this); (3) the ossifying function is more vigorous, as may be inferred from the regularity of the distribution of the new trabeculae; (4) interference with the strength of the bones is slower and less grave.

An explanation of the better defence

against toxic influence put up by the bones in osteitis deformans may be found in their greater power of resistance. Vital resistance is here implied, but the greater strength and density of the mature adult bones as compared with those of childhood and adolescence must not be overlooked. Two clinical facts also throw light upon this matter. The first is concerned with the age at which the two diseases begin. Osteitis fibrosa is a disease of young persons, starting in the first or second decade of life. Osteitis deformans, on the other hand, is an affection of middle or old age. It rarely begins before the end of the fourth or the beginning of the fifth decade, and may develop at any time between that and old age. The second is that the subjects of osteitis deformans usually show marked evidence of arterial degeneration. The argument, therefore, leads to the inference that a susceptible individual with a sufficient reserve of resisting power may stave off osteitis fibrosa in youth, but succumbs to osteitis deformans in old age when that resistance has been undermined by failing vitality and disease.

This view of the close connection between osteitis deformans and osteitis fibrosa will help to clear up some of the confusion that exists with regard to them. In well marked cases the diagnosis need never be in doubt, but there are intermediary cases in which, perhaps, the diagnosis may be in doubt.

Knaggs makes mention in his article of a clavicle, in the Leeds Medical School Museum, supposed to be an example of osteitis deformans, but microscopically proved to be osteitis fibrosa. The patient was a young woman 19 years of age. The age will be found to be a useful indication.

Radiologists, also, meet with and are puzzled by cases of undoubted osteitis deformans, in which, in some parts of the skeleton, appearances are found which they are accustomed to associate with osteitis fibrosa.

There is no inherent improbability of the occasional association in a single individual of lesions typical of both conditions.

At this point one feels that a short résumé of the abundant literature on the clinical features and pathology of these bone conditions should be inserted. The consensus of this opinion follows.

Osteitis deformans (Paget's disease of bone).—This rare and interesting condition, the exact nature of which is still unknown, was first described by Sir James Paget in 1876. The essential feature of the disease is an associated softening and overgrowth of bone. Persistent bone pains form the chief subjective symptom in the earlier stages. As to clinical features, the bones principally affected are the skull, the vertebræ, and the bones of the leg, but almost any bone in the body may be involved. As a rule the disease manifests itself in a number of bones, but in rare cases it may be confined to one bone; the diagnosis is then a matter of great difficulty. The bones of the lower limbs are usually the first to be affected, but in a number of cases the disease has been known to commence in the skull. The softened bones of the leg, having to bear the weight of the body, become bent; the femur bends outward, the tibia forward. The patient, therefore, becomes bow-legged. In addition to the bowing there may be a marked twisting, so that, as DaCosta remarks, "the femur comes to look as though it had been grasped by the hands of a giant, bent into a bow, then twisted." Other factors, in addition to that of body weight, must be responsible for the deformity, for the bones of the arm also become bent, although to a lesser degree. In this case the curve is backward. Associated with the bending, or even before it occurs, there is a characteristic thickening of the bone. The bone pains which are so constant a feature of the disease are felt partic-

ularly in the legs, seldom in the arms or head. They may be continuous or periodic. These bone pains may appear many months before any gross lesion can be detected.

Enlargement of the skull is almost always present at some stage of the disease. It may be the first sign to appear, and may first attract attention through the patient noticing that he has to buy hats of ever increasing size. The deformity in typical cases is so characteristic that it can be recognized at a glance. The head becomes a triangle, with the base above; the face usually escapes almost completely. The enlargement is due to an enormous deposit of bone on the outside of the cranium; there is no endocranial thickening. To those cases in which the facial bones and the bones of the skull are thickened whilst the other bones escape, the name "leontiasis ossea" is given.

The vertebral column is almost always involved, and marked kyphosis develops in the dorsal and lower cervical regions. As a result of the kyphosis the patient shrinks in height, a condition which is aggravated by the bowing of the legs. There are cases in which a man has lost as much as a foot in stature.

The clavicles may be affected, and, in exceptional cases, the bones of the hands and feet. The pelvis may be broadened, the ribs thickened, and the chest deformed.

The X-rays show characteristic changes long before any deformity appears. There is great thickening and increase of density of the bone, and the vault of the skull presents a peculiar serrated appearance. An X-ray examination should be made of all patients with chronic bone pains.

The appearance and gait of the patient in the advanced stages is highly characteristic. The short squat figure with the bent shoulders, the curved back, the sunken chest, the long arms, and the great head hanging forward, waddles along with bowed

legs, out-turned toes, and the aid of a stick, the living justification for the term "osteitis deformans."

This disease is slowly progressive, but may not shorten life, and is compatible with unimpaired mental activity.

The etiology of Paget's disease of the bone is unknown. Paget, himself, regarded it as a chronic inflammatory condition. French workers consider that it is a late manifestation of syphilis, congenital or acquired. In this age it is only natural that the opinion should be expressed that the condition is due to disorder of the ductless glands. The undoubted relation of the pituitary gland to acromegaly lends considerable support to this view. Hawk has demonstrated metabolic changes of importance. There is a marked retention of calcium, magnesium, and phosphorus, and a large elimination of sulphur. It has been suggested that during the formation of new bone the matrix of the osteoid tissue is abnormally rich in sulphur. As calcification proceeds the sulphur is replaced by calcium, magnesium, and phosphorus and is then excreted in the urine.

The suggestion by Cole that the primary lesion is a cardiovascular one is considered below.

In the early stages of the disease the bones are so soft that they can be cut with a knife: later they may become extremely hard. As already indicated, the essence of the disease is bone absorption, associated with or followed by increased bone formation. The bone absorption leads to great enlargement of the haversian canals.

In Paget's original specimens there were innumerable apertures for vessels, and the whole skull was finely porous. Cole, in a recent paper on the pathology of Paget's disease, lays great stress on the vascular changes in a case which he examined. The vessels in the bones showed varicosity,

thrombosis, congestion, hemorrhage and leakage with edema. Cole says: "My impression is that we have a primary blood vessel pathology such as one sees in syphilis, hereditary or acquired, with accompanying bone changes." The vascular lesions he considers infectious in origin.

Absorption is followed by the formation of new osteoid tissue, soft and pliable at first, but later becoming rigid through the deposition of lime salts. The new bone is chiefly deposited from the periosteum, but a slight deposit may take place from the medulla. The medullary cavity becomes obliterated, although not by the formation of any dense bone. It is filled with a vascular fibrous tissue which may produce soft osteoid tissue. The diploë of the skull disappears and the distinction between the outer and inner tables is lost.

Paget's disease is a strong predisposing cause towards the development of sarcoma of bone. This has occurred in nearly 10 per cent of the recorded cases.

Osteitis fibrosa cystica.—This rare condition was first described by Von Recklinghausen in 1891, and is sometimes known as Von Recklinghausen's disease, an undesirable term which should be confined to the multiple fibromata occurring upon the cutaneous nerves. The disease consists in the formation of new vascular connective tissue which may soften and give rise to cysts. Bloodgood and others consider that the condition is essentially an inflammatory one, a low grade form of osteomyelitis. On the other hand, there is evidence to suggest that this is one of those obscure disorders of calcium metabolism and ossification of which Paget's disease, osteomalacia, achondroplasia, rickets, and hereditary multiple chondromata (hereditary deforming chondrodysplasia) are other examples. In this respect the name of "juvenile osteodys trophy" is quite appropriate.

Considering the clinical features, the disease is essentially one of early life. Most of the cases occur between the ages of 10 and 20, but in Bloodgood's series one patient was only 2½ years old. Cases after the age of 20 are almost unknown, and if a case requiring differential diagnosis occurs later in life it is likely to be an example of Paget's disease or osteomalacia, or the localized form of osteitis fibrosa.

The symptoms are by no means proportionate to the degree of bony change. Of the three principal symptoms—pain, swelling, and fracture—pain is rarely a prominent feature and the swelling occurs late. Very many patients come for the first time complaining of spontaneous fractures. Owing to the softening of the bones, which are very poor in lime, there may be bowing of the arms and legs, and these deformities are often very angular and irregular. The bones most commonly affected are the humerus, the femur, and the tibia, in the order named. The jaw, the skull, and the bones of the trunk may occasionally be involved. There are two main clinical types: the localized, in which one bone is affected, and the general, in which a number of bones are attacked. The latter is quite rare, as stated above, there being only four cases in Bloodgood's series of sixty-nine cases of osteitis fibrosa cystica.

The X-ray examination of the cysts reveals a striking picture. The clear area is often continued down the shaft as a pointed extension; in other bone cysts, such as those which occur in giant-cell tumors, the lower limit is rounded.

The disease is of long duration, and may be complicated by the development of a relatively benign giant-cell tumor.

Under the head of *morbidity anatomy* the first point to be noted is that the medullary tissue is replaced by new connective tissue, with or without cystic formation. It is im-

portant to note that the cyst formation, the dramatic feature of the disease, is by no means essential. In this respect the condition resembles the so-called multiple cartilaginous exostoses in which the development of exostoses is interesting but incidental.

The main pathological features are a general and diffuse degeneration and absorption of bone, a growth of vascular connective tissue, cyst formation, the rather frequent development of giant-cell tumors, and spontaneous fractures. The cysts are usually small, but may attain a considerable size. The wall of the cyst may become much thinned, and in the case illustrated (Case 1, Fig. 1) it was in places as thin as parchment, so that the slightest trauma was sufficient to produce a fracture. The cysts are lined by fibrous tissue. The fluid contents of the cysts are never distinctly hemorrhagic; they are usually thin, dark brown in color, and show microscopically a few blood cells. Frequently, however, the cysts are filled with gelatinous or fibrous masses rather than with fluid.

The bones are remarkably porous, so that curvatures and angular deformities are fairly common. Sections of bone show a bony meshwork enclosing vascular marrow-like tissue. The compact bone may have largely disappeared.

In a considerable number of cases osteitis fibrosa is complicated by the development of a relatively benign giant-cell tumor. Giant cells are found even more frequently in the walls of the cysts and in the new connective tissue. In one of our own cases tumor growth began after the disease had existed for a number of years, but in this case the tumor was not of the giant-cell type but an ossifying sarcoma which killed the patient.

Bone cysts occur as a complication in many diseases of bone. Bloodgood gives the following list in addition to osteitis

fibrosa cystica: multiple chondroma, myxoma, giant-cell sarcoma, osteitis deformans, subperiosteal hematoma with a bony wall due to an ossifying periostitis, and callous cysts. To these may be added bone abscess, echinococcus cysts, and osteomalacia.

Osteomalacia.—This disease is of extreme rarity on the North American continent, but is fairly common in the Rhine Valley and in Northern Italy. Numberless theories have been suggested to explain the condition, but it is probable that, like rickets, it is a deficiency disease due to the lack of some vitamine in the food plus chronic infection. The disease is one of middle life, and is almost confined to women, especially those who are pregnant or who are exhausted through bearing large numbers of children. Many bones may be affected but those exhibiting most the effect of the disease are the lumbar vertebrae, the pelvis, and the bones of the legs.

All the symptoms are due to a decalcification of bone, the lime salts being removed, the organic parts left uninjured, so that the bone can be bent, cut, and sometimes actually squeezed like a sponge. An excess of lime salts is excreted in the urine and the feces. The bone marrow is extremely vascular. The periosteum may occasionally lay down new bone on the surface, but, there also, calcification is very incomplete. The vertebrae become compressed, so that the patient may rapidly lose height. Softening of the pelvis may lead to a deformity which may make normal delivery impossible. The promontory of the sacrum comes forward and the pressure of the head of the femur drives the acetabulum inwards, so that the pelvic inlet is greatly distorted and narrowed. The thorax is compressed laterally. In the leg, the bones are curved forward and outward. In its effects, therefore, as well as in its causation the disease bears a distinct resemblance to rickets.

Achondroplasia.—Another disease which bears some resemblance to rickets is achondroplasia, sometimes called "fetal rickets." It affects bones developed in cartilage; that is to say, the long bones and the base of the skull, whereas the bones of the face, developed in membrane, escape. The essential basis of the condition, as the name implies, is a malfunctioning of the epiphyseal cartilage, so that the long bones do not increase in length, and the result is a stunted dwarf with short arms and legs. The epiphysis is enlarged, and, with the short diaphysis, the appearance of a long bone has been likened to a collar stud. The head is large, the bridge of the nose depressed, the hands and feet squat, the fingers of equal length—the so-called "trident-hand."

The cells of the epiphyseal cartilage show no sign of proliferation, and, although enlarged, are not arranged in definite rows.

The cause of the condition is unknown, but it may well be due to defective secretion on the part of one of the ductless glands which regulates skeletal growth.

Hereditary deforming chondrodysplasia.—This remarkable condition is known by a variety of other names, such as "multiple cartilaginous exostoses," "hereditary multiple exostoses," and "multiple congenital osteochondromata." As the names imply, these terms indicate that the disease is sometimes regarded as a form of neoplasm, sometimes as a hereditary disturbance of the metabolism of cartilage and bone.

Considering the *clinical features*, the disease, which is about three times as common in males as in females, begins in early life. It is characterized by the appearance of multiple growths in the bones. These growths, however, are merely incidental, not the essence of the disease. They are, as a rule, first noticed during the first decade of life. Almost any bone in the body may be involved, but those affected are, in

their order of frequency, the femur, tibia, humerus, fibula, radius, ulna, the phalanges, the ribs, scapula, and the pelvic bones. It will be noticed that the flat bones as well as the long bones may be affected by the disease. The bones of the face and the skull are rarely involved; they are laid down in membrane, not in cartilage. The changes to be observed may be divided into two main groups: (1) growth retardation and (2) proliferative changes.

Growth retardation may affect the form, length, and thickness of the bone, a fact which is best seen in the metacarpal bones. The different metacarpals may vary markedly in size and shape and this is particularly true when X-ray films of the two hands are compared. Similar changes are seen in the scapulæ and pelvic bones. The acromial process may be very large, the body and glenoid process very small. In most cases the bones attain to a normal length, but remain thin and delicate. Such bones as the radius, ulna, tibia, and fibula may show a considerable amount of bowing, due probably to unequal growth of the two bones. Cyst formation may be visible in the X-ray film. In a case of Carman's there were large cysts in most of the lesions, and the upper part of the shaft of the humerus was entirely cystic on both sides. The stature is stunted, owing to the short legs. The under-development of the fibula may give rise to a condition of pes valgus; that of the radius may cause a marked deformity of the wrist with ulnar deviation.

Proliferative changes are to be observed both distal and proximal to the epiphyseal line. The early disappearance of that line itself is a striking feature of the X-ray picture. In the epiphysis there is an enlargement and distortion of the bone. The neck and greater trochanter (but not the head) of the femur, the condyles of the femur, and the head of the tibia may show great en-

largement, but no definite outgrowths. In the head of the fibula and the acromial process of the scapula, on the other hand, distinct growths, epiphyseal in origin, may occur. Changes in the ends of the diaphysis are well seen at the lower end of the femur and at both ends of the tibia. They consist of curiously shaped outgrowths, sometimes stalactite-like in form, which may encroach upon the epiphysis, but originate in the diaphysis. In the shaft of the diaphysis the common change is the appearance of a number of definite exostoses or of nodular, partially organized swellings of the periosteum. The growths often appear as the result of an injury to the bone. It would appear that the bone is specially sensitive to injury, and reacts in this way. The nodules may gradually disappear, or may become completely ossified. The relation of the exostoses to the deformities due to retardation of growth is variable. In some forms of the disease the exostoses never develop. In other cases, exostoses may appear in bones which show no deformity, whilst some of the deformed bones may show none.

The disease ceases when skeletal development is complete. The patient usually comes to the surgeon about the age of puberty because of pes valgus, pressure symptoms, or general bone pains.

The pathologic nature of the disease appears to be a disturbance of bony metabolism occurring early in life, and, it may be, *in utero*. The metabolic studies of Honeij are worthy of note. This observer found that "in the stabilized stage of the disease calcium exchange differs little from that of a normal individual, whether the abnormal subject is maintained on a calcium-poor or a calcium-rich diet. In the progressive stage of the disease calcium metabolism is markedly different from the normal in that calcium is lost from the body."

Nests of cartilaginous cells may be left

under the periosteum covering the ends of the shaft. These remain uncalcified but at a later date they may develop into cartilaginous exostoses or chondromas.

Fragilitas ossium.—Undue fragility of the bones may occur as a complication of fetal life, or may not appear until the individual has grown up. The congenital form is known as "osteogenesis imperfecta." Many fractures may occur *in utero*, and, if not, they are certain to take place at time of birth. The skull presents a remarkable condition, for the vault is made up of a large number of small fragments pieced together in mosaic fashion, and separated by unossified membrane.

The adult form, as also the congenital, is frequently familial. In the literature there is a report of a family in which six members suffered from multiple fractures, and there were several other victims on the mother's side. In this case the calcium content of the urine was below normal. In both forms the bones are light, porous, and rarefied, so that fractures may occur on the slightest provocation. There must be some disturbance of calcium metabolism, but its exact nature is quite unknown.

Osteochondritis deformans.—It is only within the last dozen years that this condition has come to be recognized. Nomenclature and priority claims both present knotty problems which need not be entered into here. One of the first to recognize the condition as a distinct entity was Legg, of Boston, who described 5 cases in 1909. The next year Perthes, of Tübingen, published a careful account of the condition, which he has followed up by a series of papers, and the disease is frequently known as "Perthes' disease." Other names commonly employed are "pseudocoxalgia," "osteochondritis deformans juvenilis," and "epiphysitis of the head of the femur."

Most of the cases occur between the ages

of 5 and 10; the disease is unknown after the age of 15. It is more common in boys than in girls; in one series of cases the proportion was four to one. A history of recent injury is often given. The earliest sign is a limp, usually accompanied by little or no discomfort, although occasionally there may be pain in the hip or knee. There is slight restriction of mobility affecting the movements of abduction and internal rotation. There is little or none of the atrophy of the buttock and thigh so characteristic of tuberculous disease of the hip, nor is there any thickening of the soft parts overlying the joint. A mild degree of irregular pyrexia is not infrequently present. The picture is that of a mild transient synovitis of the hip joint. After a varying period the symptoms disappear. Two signs, however, persist during life—thickening of the trochanter and limitation of the range of abduction.

The X-ray picture is absolutely characteristic, and it is by means of it that a final diagnosis can be made. The head of the femur is distorted and flattened, while the neck is broadened and stunted. The acetabulum becomes altered to conform with the final shape of the head. Where the discrepancy in size is great the acetabulum is shallow. A full discussion of these matters will be found in Platt's paper (*Brit. Jour. Surg.*, 1922, IX, 366).

As to the morbid anatomy, very few opportunities have presented themselves for an examination of the diseased tissues. The most important contribution is that of Phemister, who removed a portion of the head of an affected femur. The joint cavity showed evidence of an acute synovitis, but the articular surfaces retained their normal sheen. The center of ossification of the epiphysis was broken down, forming a cavity which was filled partly with granulation tissue, partly with necrotic debris and a number of small sequestra. Cultures and

animal inoculations proved negative. Histological examination suggested an old, probably pyogenic, infection which had destroyed most of the head of the femur. The restricted nature of the infection might be accounted for by the fact that the center of ossification is everywhere surrounded by a wall of cartilage which resists the spread of the inflammatory process. As this layer of cartilage is not pierced by nerve fibers, the center of ossification has no nerve supply, which would account for the absence of pain.

Many suggestions have been made regarding the essential cause of the disease; trauma is a factor frequently mentioned. Legg considered it to be the sole determining factor; that the injury caused an obliteration of part of the blood supply to the epiphysis which accordingly atrophied, whilst a compensatory hyperemia of the neck led to corresponding thickening. This somewhat fantastic hypothesis has little to support it.

Rickets has also been suggested as a causal factor, but with even less foundation. Needless to say, endocrine dysfunction has been dragged in to explain this obscure condition, and, as usual, without the slightest justification. The theory that the disease is due to a low grade infection is the most probable one. The occasional occurrence of pyrexia would bear this out. The pathologic findings of Phemister agree with it. Trauma may well determine the occurrence of the disease in the hip, just as it plays an important part in the production of osteomyelitis elsewhere.

One approaches the radiographic consideration of osteitis deformans and similar bone diseases with a feeling akin to dread of the results in a differential diagnosis. The classical appearance of the radiographic shadows noted in osteitis deformans, which are so familiar to us all, had best be described. The disease shows a thickening of

the cortex on both sides of the bone, a thickening of the bone and a bending or bowing. The trabeculae are arranged in strands or bundles running longitudinally. The new cortical bone may show numerous longitudinal cyst-like areas. These multiple cysts are also seen in the medulla. There are, as well, mottled areas of rarefaction in the medulla which extend into the epiphysis. The involvement of the epiphysis is an important point in differentiation from lues, which rarely affects the epiphysis in the same manner. There is proliferation of periosteal bone which also causes widening of the bone. This proliferation, however, is often eccentric, occurring on one side of the shaft of a long bone.

The changes in the skull, when present, are most characteristic. There is great thickening of both tables and a coarse mottling throughout the diploë due to alternating areas of increased and diminished density. These areas are round, knob-like masses. Baetjer aptly describes this appearance by imagining the curly, kinky hair of the negro as having undergone calcification. These changes result in an increase in the size of the head.

When the spine is affected the softening of the vertebral bodies causes an anterior bowing. These changes as shown by the radiograph in the spine of a Paget's disease may be very easily confused with an osteoplastic type of carcinomatous metastasis. If one or two vertebrae are the only bones affected, a differential X-ray diagnosis is impossible without the history and clinical findings.

Sarcoma development.—Though not a frequent complication, one need not be surprised to discover that osteogenic sarcoma has developed in a case of osteitis deformans. This fatal complication was noted by Paget in his original article and has been noted since with a fair degree of frequency in the literature. A rather extensive arte-

riosclerosis is a usual accompanying complication of osteitis deformans.

A description of the *radiographic findings of osteitis fibrosa cystica* will be found to be very similar. The bone trabeculae are arranged in much the same manner as in osteitis deformans, namely, in bundles or strands running longitudinally. The same bending is noted and the medulla and cortex both show cystic formation arranged in a longitudinal manner. This description applies to both the generalized form and the form of osteitis fibrosa which is localized to one bone. In the generalized type one notes the almost complete absence of the thickening of the cortex and the periosteal bone proliferation so constantly encountered in Paget's disease. The bones, however, will be misshapen and bent from the patient's weight on the osteoporotic bone and enlarged from the cystic formations in the cortex and medulla. Also, the rather constant findings of a marked arteriosclerosis, nearly always present in osteitis deformans, are usually absent in osteitis fibrosa. This one would expect, as osteitis fibrosa is a disease of the young.

The development of osteogenic sarcoma and of benign giant-cell sarcoma occurs with about equal frequency in osteitis deformans and osteitis fibrosa, which is presumptive evidence that these diseases, if not identical, are certainly closely allied. This, in view of the trend of modern thought, may be considered as having some bearing on the fact that both conditions are due to chronic inflammation, as it is thought that chronic inflammatory processes produce cancer.

The radiographic findings noted in cases of osteomalacia are those of a marked osteoporosis; in other words, the shadow cast by the bones is very faint—lace-like in appearance—and the bone trabeculae show very irregular distribution but also are somewhat longitudinally arranged. The de-

formity and bending of the bones is probably more marked than in Paget's or osteitis deformans. Pathologic fractures occur with great frequency, probably with more frequency than in either of the diseases just mentioned. Osteomalacia is closely allied with osteogenesis imperfecta and osteitis fibrosa; in fact, it is possible to classify these latter conditions as forms of osteomalacia, and, in view of the present trend of thought, one must include osteitis deformans in this class.

As stated above, osteomalacia develops in patients who have been subjected to unhygienic surroundings and debilitating conditions, whereas the other conditions develop in patients who are not subjected to such conditions.

It is felt that a discussion of these diseases is incomplete without mention of osteogenesis imperfecta (*fragilitas ossium*, *periosteal dysplasia*, or *osteopsathyrosis*). In the infantile form of this disease, the bones show a great diminution of the lime salts and thinning of the cortex, but their size and form remain unchanged. Multiple spontaneous fractures are frequent occurrences.

The appearance of the skull is considered a characteristic feature of this disease, the calvarium, composed of a great number of small plaques of bone united by fibrous tissue, having a mosaic appearance. In the adult form of the disease the bones appear nearly normal in size and calcium content, but present numerous deformities due to the multiple spontaneous fractures which have occurred. These patients often show progressive osteosclerosis.

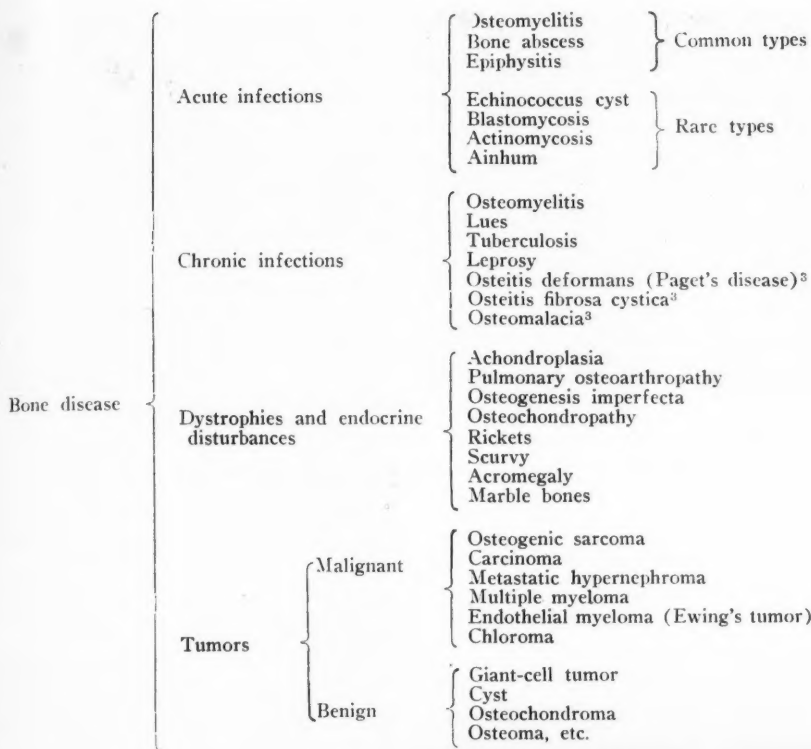
Probably it is incorrect to consider this condition in the same class with osteitis deformans, osteitis fibrosa, and osteomalacia, as, though there may be a background of infection as a causative agent, yet this condition seems more properly classed with the dystrophies. Other members of this group

are osteochondropathy, pulmonary osteoarthropathy, achondroplasia, rickets, and scurvy. In pathology, all are so closely related that one hesitates to attempt to make a sharp demarcation, yet the author has the temerity to submit the classification which follows (page 293).

Such a classification might be used as a working basis for research by an association of physicians, surgeons, pathologists, and roentgenologists working together in a group like that of the Registry of Bone Sarcoma. Is it not conceivable that more knowledge could be gained and a greater field opened for study and research of these little-known, baffling conditions, which would lead us into yet undiscovered fields and in all likelihood change not only our classification but our entire conception of these bone diseases?

CASE REPORTS

Case 1.—J. H., aged 50 years, had his attention first drawn to the condition by a gradually increasing disability of his right wrist joint, which interfered with his occupation. He then noticed that there was a marked posterior bowing of the forearm and a resulting deformity of the wrist joint. There was no pain or tenderness except a dull ache in the wrist joint following use of the hand. The past history was irrelevant except for an attack of typhoid fever in February, 1913, complicated by spontaneous rupture of the spleen, with operative splenectomy. Following the operation the patient had infarcts in both lungs and phlebitis in both legs. He also had a post-typhoid neuritis of the external cutaneous nerve of the right leg and two months after the typhoid he developed a trifacial neuralgia. No history of infectious disease other than the typhoid. The family history is negative. The physical examination is also negative except for the changes in the right forearm.



³These conditions may also be governed by endocrine disturbances.

The radiograph (Fig. 1) shows a definite osteitis of the right radius. The changes are a fibrosis and definite cystic formation, with an elongation of the bone and a posterior bending due to a bony over-growth, yet there is no evidence of an increase, but, rather, a decrease in calcium and no periosteal bone proliferation. The elongation and bending cause an anterior displacement and tilting of the radio-carpal joint, and complete dislocation of the inferior radio-ulnar joint and a posterior dislocation of the ulna on the carpus.

Urine analysis and other laboratory tests were negative. Blood calcium not estimated.

In December, 1926, the patient was operated upon and the lower third of the radius opened in the medullary cavity. The lower part was found to be sclerosing. In



Fig. 1 (Case 1). Osteitis fibrosa cystica.



Fig. 2 (Case 1). An illustration of the localized type of osteitis fibrosa cystica, involving the left shoulder.

the upper portion two cavities, resembling so-called cysts, were exposed and evacuated. The soft parts were allowed to drop in to obliterate the cavity.

The microscopic report shows osteitis fibrosa cystica. Microscopic sections show cancellous bone. The meshes are filled with a loose fibrous connective tissue. A row of osteoblasts are seen along the bony trabeculae and also a remarkably large number of giant cells (osteoclasts), indicating a marked degree of lacunar absorption of bone. Cultures from the material removed at operation and of the medullar cavity made on various media were all negative for bacterial growth.

This case clinically, pathologically, and from the radiographic findings is unquestionably an osteitis fibrosa cystica limited to the right radius, and apparently the attack of typhoid fever in 1913, with the numerous complications, was the exciting cause. One's feeling is that the chronic infection of the right radius lay dormant since the typhoid, but within the past two years has become active, due to some calcium imbalance—possibly because the patient has grown older and also possibly be-



Fig. 3, above (Case 3). Osteitis deformans of the lower end of the right femur. The pelvic bones, one phalanx of one metacarpal bone, and the right femur are the only bones involved.

Fig. 4, below (Case 3). Osteitis deformans involving the fourth and fifth lumbar vertebrae, sacrum and left ilium, and right ischium and greater tuberosity of right femur.

cause of some disturbance in the internal secretions.

Case 2.—T. H., aged 34 years, was admitted to the hospital with complaint of pain and some limitation of motion in right humerus. Otherwise his health was good. Past history elicits that the patient while in the Army during the World War developed an abscess in the cervical region, the cause of which was undetermined. This occurred about July 10, 1918. On October 20, 1918, he was admitted to Base Hospital No. 56



Fig. 5 (Case 3). Osteitis deformans of right femur.



Fig. 6 (Case 3). Osteitis deformans involving the first metacarpal bone of the right hand and the first phalanx of the index finger. This very beautifully illustrates the involvement of a few bones, a condition sometimes encountered in Paget's disease.

itis, one seems justified in naming this a manifestation of osteitis fibrosa cystica.

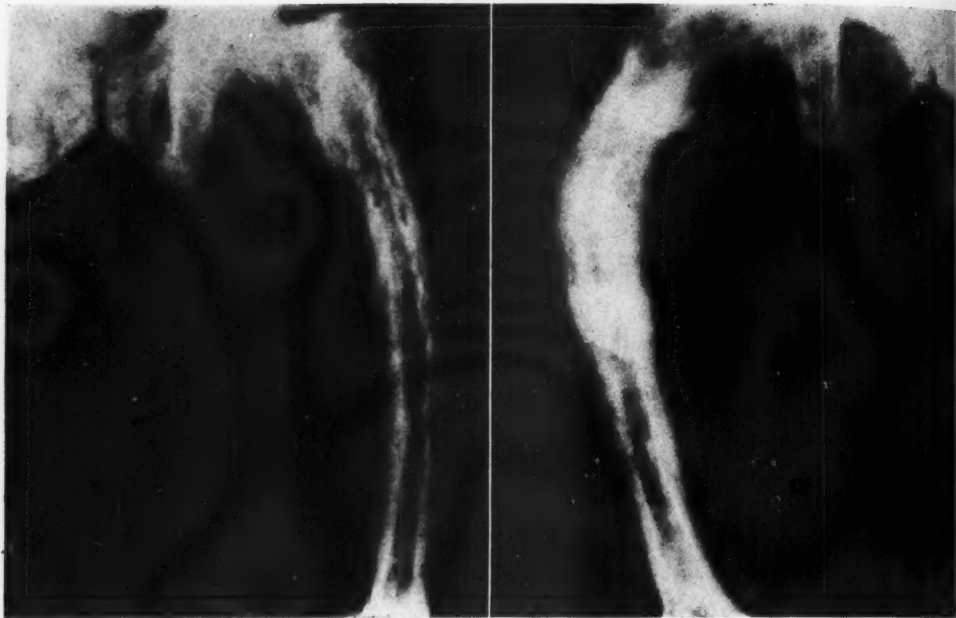
for this cervical lymphadenitis, which was said to be secondary to an active pharyngitis. He remained in the hospital until November 18, 1918, when he was discharged as cured. He noted nothing further and was discharged from the Army.

About two years ago the patient noted slight pain in the shoulder, which he regarded as rheumatism, but the pain persisted, became worse, and there was a gradual increase in the disability, which prompted him to seek medical advice.

The radiographic findings (Fig. 2) show an osteitis with fibrous changes and cystic formation in the medulla and cortex, causing some enlargement and disturbance of the normal outline of the bone. In the absence of a marked bone production, the age of the patient, and the history of a focus of infection, namely, the cervical lymphaden-

Case 3.—Mrs. T., aged 50 years, was referred for radiographic examination. She has been a missionary in the Philippine Islands for years. For a considerable period of time she has suffered from what she terms "rheumatism," for which she has received varied medications but without relief. A complete history of this case was not secured owing to the fact that the patient was referred for radiographs only and left for the Philippine Islands shortly after the examination. She has since been heard from through her physician, who states that her condition is becoming progressively worse. Her pains are about the same, but her disability is increasing and she finds walking correspondingly difficult.

The radiographs (Figs. 3, 4, 5) show changes in the bone to be a fibrous cystic degeneration. The bone trabeculae are arranged in longitudinal bundles, also being mottled by areas of decreased density which indicate absorption of calcium, and also a



Figs. 7 and 8 (Case 4). See text, page 298.

suggestion of beginning cystic formation. The rather unusual feature in this case is that (Fig. 6) the hands show an involvement in one of the first metacarpal bones. The skull shows no evidence of the changes of Paget's disease.

This might be classed with Case 4 as a doubtful case of osteitis fibrosa cystica of the generalized type, due entirely to the lack of involvement of the skull. However, the author does not feel that the lack of involvement of the skull excludes Paget's disease. Due to the patient's age and the fact that her symptoms have been present for not more than six or eight years, it would seem that this is a case of Paget's disease without involvement of the skull.

Case 4.—H. P., aged 52 years, was admitted to the hospital on July 13, 1915, and discharged November 4, 1915. On the evening of admission the patient was standing on a window-seat 18 inches above the level

of the floor. He was holding a heavy curtain, and, in attempting to step from the window-seat to the floor, his foot slipped and he fell to the floor, from which he found it impossible to rise. He had very little pain but knew from the deformity that his thigh was broken. The patient has always felt that the right leg is not as strong as the left, and when a child he noticed that he could not do things with the right leg that he could with the left. When about 30 years of age he had an accident, with a resulting contusion of the right leg. Later two abscesses developed near the tibia, which necessitated treatment for two months, most of which time he was confined to bed. For some seven weeks previous to admission the patient says he has had rheumatism and pain in the bone in his right thigh, the pain being especially severe in the anterior muscles over the middle third of thigh. The pain was made better by resting and was less severe at night. There was also weak-

ness in the right thigh, more pronounced than previously. He used a cane because he felt the leg could not support him, and he also walked with a slight limp. The past history was otherwise negative and the family history was irrelevant.

Physical examination was negative except for the right leg, which showed no evidence of contusion or external violence. The limb was held in external rotation. There was marked anterior bowing just above the middle of the thigh, and extreme tenderness in this region. A mass was felt, apparently the upper fragment of the fracture. It was palpable anteriorly and a corresponding mass was felt posteriorly. There was crepitus on motion. The right leg was one inch shorter than the left.

The X-ray examination showed pathological fracture of the right femur, with bony changes indicating an osteitis. These changes consisted in a disturbance of the bone trabeculae, osteoporosis and cystic formation in the cortex and medulla, with some evidence of periosteal bone production and a widening and bending of the bone.

The fracture healed satisfactorily and patient was discharged as cured on Nov. 4, 1915. He was afebrile throughout the course of his convalescence from the fracture. His urine was practically always normal and his blood count showed nothing unusual.

On January 1, 1916, the patient was readmitted with the following history: A few minutes before admission, while he was getting off a train, his crutch slipped, and he fell a distance of two steps, striking his right heel with considerable force. His thigh became very painful at the site of the old injury and there was an apparent deformity. On admission, the deformity and swelling were clearly seen, and there was tenderness. The history was as recounted above on the previous admission.

X-ray examination at this time showed a



Fig. 9 (Case 4). See text, page 298.

recent pathological fracture at or near the site of the previous fracture and the changes were the same as in the previous examination except that the condition seemed still more advanced and was complicated by callous formation about the old fracture. Nothing else of interest was found in the history. The patient was discharged, with a firmly united fracture, on February 9.

On October 17, 1916, he was again admitted to the hospital with another fracture of the right femur near the site of the two previous pathological fractures. There was nothing further of interest in his history except that this fracture was sustained, as in the previous instances, with a minimum amount of trauma, namely, that he missed one step and the resulting jar caused the injury. The X-ray examination at this time showed distinct advance in pathological changes in the bone, and the left tibia showed the changes noted in Paget's disease. His blood calcium was never estimated. The blood count was normal, as

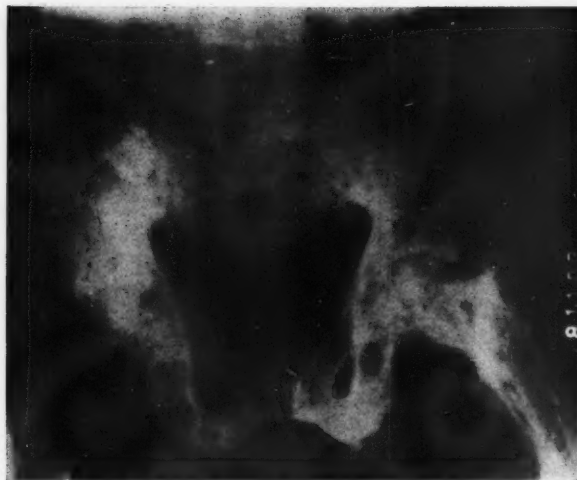


Fig. 10 (Case 4). See text, page 298.



Fig. 11 (Case 4). See text, page 298.

was urine analysis; blood pressure was within normal limits for a man of his age.

Summary.—This is one of those cases in which a question arises as to what classification is to be applied. The X-ray examination and the patient's history show an osteitis involving numerous bones of the body. The condition is progressive, as the patient was examined roentgenologically in February, 1927, as shown in Figures 7 to 11. This case, however, has never had involvement of the skull. Also, the patient has given a history of slight disability in his right thigh since childhood, following abscesses on the leg. The question arises, Is this case one of so-called osteitis fibrosa which the patient had for some forty years before sustaining pathological fractures and in which the skull has never been involved? On the other hand, are we to class this as a case of osteitis deformans without involvement of the skull, and are we to consider that the previous disability and weakness of the right thigh and the previous infection were in no way related to the present bone disease? It seems that this case is one of those that simply cry out for further investigation.

Case 5.—F. D., aged 41 years, sustained a severe fall while walking fast and was thrown over a low table, causing a fracture of the left femur. For about six months previous to the injury the patient had noted a slight pain in the right leg. This pain was in the nature of a soreness which the patient could not sharply localize; he thought it was probably rheumatic. It seemed to work out when he exercised. He felt tired and slightly under par previous to the injury. He also had had headaches for some six months previous to the injury, which are continuing. No family history of similar injuries. Father died of rheumatism; mother died of shock. Patient had had uniformly good health save for childhood diseases and occasional attacks of tonsillitis. His personal history is irrelevant. He presents slight bowing of both legs, particularly of the femurs, and since sustaining the fracture has had to walk with a cane. His left knee is slightly limited in motion but there is no stiffness of the hip. His height seems not to have undergone change. His skull shows slight thickening over the occipital protuberance. It is rather large and square



Fig. 12 (Case 5). See text, page 300.

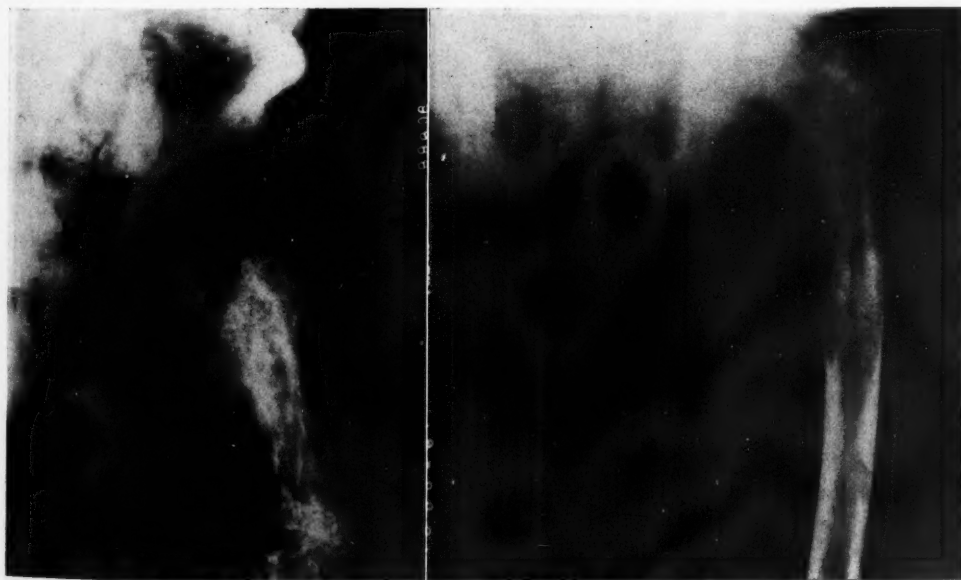
in appearance, but the face is fat, so that it has not the typical triangular appearance.

X-ray examination revealed marked osteitis of the left femur, with the pathological fracture. In addition, the bones of the pelvis and the upper half of the right femur were similarly involved. Also, definite changes in the lumbar spine and the posterior portion of the skull in the occipital



Fig. 15 (Case 5). See text, page 300.

and occipito-parietal regions showed definite thickness, with abnormal distribution of the trabeculae. Also, in the parietal regions



Figs. 13 and 14 (Case 5). See text, page 300.



Fig. 16 (Case 5). Skull in osteitis deformans, showing slight thickening over occipital protuberance.

there was a suggestion of a beginning typical appearance, as described by Baetjer. These findings were interpreted as due to Paget's disease (Figs. 12 to 16).

Summary.—This case shows essentially the same X-ray findings as noted in Case 4. In this case the skull did show changes, so that here again the question arises as to which classification is to be applied. One school would claim that this was unquestionably a case of Paget's disease because of involvement of the skull. The other school would claim there is no case that is true osteitis deformans without the involvement of the skull, yet the changes in the long bones and the bones of the pelvis and in the spine in this case and in Case 4 are very similar.

Case 6.—G. W. N., aged 47 years, was admitted to the hospital on February 7, 1927. The chief complaint was deformity of the bones and soft parts, with pain. The present illness began three years before, when the patient noted a small lump on the anterior aspect of his left tibia. This was hard and bony in character and gradually increased in size, but was not painful except when struck. At a slightly later period the left knee began to swell and was painful,



Fig. 17 (Case 6). Osteitis deformans involving the skull, showing typical lesion.

and became stiff. Two years before admission the patient sustained a fracture of the right humerus while throwing a baseball. Shortly after this had healed he fractured his left clavicle in alighting from a trolley car. About one and one-half years before examination the upper end of the left humerus began to swell and the shoulder began to stiffen. The patient was able to abduct the arm only to a right angle. In December, 1926, the shoulder became very painful and the patient complained of great heat in it, while the swelling increased rapidly. During the entire course of his illness the patient had noted an increasing bowing of the legs and an increase in the size of his head, stating that his head felt lumpy. He had a gradual increase of pain in his back and legs. A tumor mass appeared on the anterior aspect of the right humerus, at the site of the previous fracture, about three weeks previous to admission. At about the same time the patient noted a cystic swelling in the right temporal region and about a week later two similar, though smaller, swellings appeared on the left forehead. He also complained of difficulty in walking and inability to adduct the left

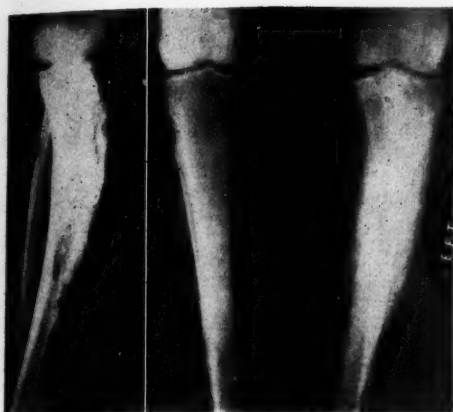


Fig. 18, left (Case 6). Osteitis deformans of the left tibia, showing the characteristic bony changes and anterior bowing. In addition, there is calcification of the arteries, which is also a frequent finding in Paget's disease.

Fig. 19, right (Case 6). Osteitis deformans in the left tibia, showing the changes in the bone and the periosteal bone production on the outer side of the shaft, characteristic of Paget's disease. This change might be simulated by a luetic osteitis.



Fig. 20 (Case 6). Osteitis deformans of the left humerus, showing characteristic bony changes—deformity of bone and irregular new bone formation. The added feature of interest is the soft-part swelling about the middle third of the arm, thought to be extraperiosteal fibrosarcoma.

femur, due to a hard bony mass in the region of the lesser trochanter.

The past history comprised the usual childhood diseases but no other diseases or infections. The man had always been athletic in his habits. His family history was negative, except that the cause of his mother's death at 86 was unknown. There was no history in the family of disease similar to that presented by the patient.

Physical examination revealed an undernourished white male, appearing chronically ill. Inspection showed a typical enlargement of the cranium and a face triangular in appearance. The anterior bending of the spine and the anterior bending and bowing of the femurs and left tibia gave the typical posture of Paget's disease. Over the right temporal bone was a cystic mass about 4 centimeters in diameter. In the left frontal region were two firm masses about 1.5 centimeter in diameter. The left clavicle was prominent, thickened, and a firm mass about the size of a walnut was present near the

outer end. The heart and lungs were negative. The liver showed some enlargement. The extremities showed bowing of tibias, especially the left, bowing and thickening of both femurs, and a hard bony mass in the region of the lesser trochanter. The knee jerks were active. The left shoulder showed definite fusiform hard swelling of the upper third of the arm, definitely impairing the shoulder movement. The skin appeared fairly normal and the temperature of the skin was not elevated. Over the anterior aspect of the right humerus, about its middle third, was a hard swelling about the size of a plum. It was fixed, and seemed attached to the bone. In the lower portion of the left arm was a similar hard swelling, but smaller. The left knee showed a generalized swelling, most marked on the

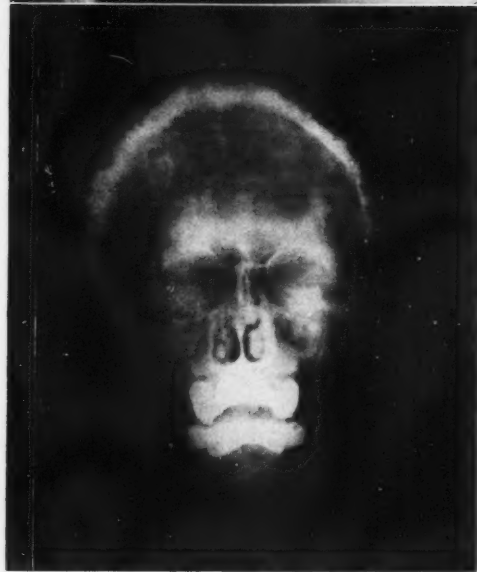
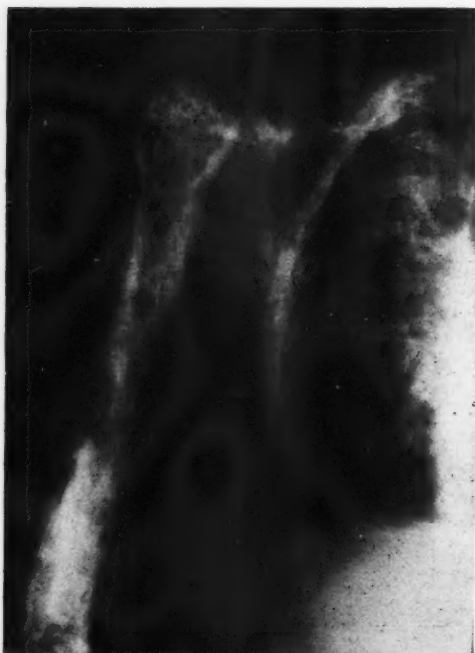


Fig. 21, above (Case 6). The right humerus. (Cf. Fig. 20.)

Fig. 22, below (Case 6). Osteitis deformans involving the skull; typical lesion.

inner side. The ankles and feet seemed normal.

X-ray examination showed marked cor-

tical thickening, irregularly striated; periosteal bone production and cystic formations in the left tibia, both femurs, bones of the pelvis; and spine. In addition, there was a marked increase in the size of the lesser trochanter of the left femur, giving the appearance of a large osteoid tumor. Examination of the skull showed marked deformity and thickening of the cranial bone, with irregular calcific deposits between the outer and inner tables. The right humerus showed the same changes as noted in the other long bones, and a tumor in the soft parts could be clearly seen. The left clavicle also showed degenerative changes and evidence of the old fracture. The upper end of the left humerus was almost completely destroyed, but showed some irregular calcific material in the region of the extensive tumor which invaded the soft parts. X-ray diagnosis was typical Paget's disease, with degeneration and formation of an osteogenic sarcoma (Figs. 17 to 25).

Laboratory examination. — The blood showed red cells 4,592,000; hemoglobin 47 per cent; white cells 9,800; polymorphonuclears 76 per cent; lymphocytes 21 per cent; Wassermann, negative. Blood calcium: at first, 10 milligrams per 100 c.c.; later, 12 milligrams per 100 c.c. Urine analysis, negative; no Bence-Jones bodies; urine calcium, 0.211 grams in 24-hour output.

During the patient's stay in the hospital his temperature varied between normal and 99° for the first seventeen days. On the eighteenth and nineteenth days it was 102°. It then returned to the previous range of from normal to 99°, until a few days before death, when it ranged from 100° to 103.5°. A consultation was held and it was decided that the numerous tumor masses were due to sarcomatous degeneration, for which high voltage therapy was advised. The patient was given 8 therapeutic exposures to the left shoulder, anterior and posterior; to lower dorsal and lumbar

spine; to left groin and femur, and the right humerus, both anterior and posterior. Dr. John Remer gave these treatments, using the following factors: 200,000 volts; 4 ma.; 50 cm. distance, with 0.5 mm.

admitted, but they had grown worse. Two of his injuries had occurred since the onset of his present illness. These attacks were always preceded by an aura and accompanied by spastic movements of the extrem-

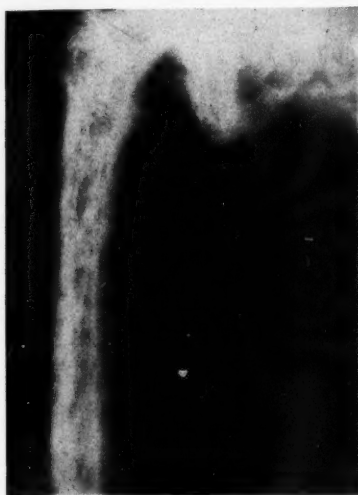


Fig. 23 (Case 6). Osteitis deformans, showing characteristic bone changes in the right femur and ischium, with irregular calcific destruction and cystic formation.



Fig. 24 (Case 6). In this, the left femur, there is the added feature of a large osteoma forming from the lesser trochanter.

copper and 1 mm. aluminum filter. The total dose administered was 70 per cent depth dose to the different areas. Though the X-ray therapy resulted in no decrease in size of the sarcomatous masses nor X-ray evidence of changes, there was very marked relief from the patient's symptoms of pain and general discomfort. He died on the forty-fifth day in the hospital and no autopsy was obtained.

Case 7.—Mr. McD., aged 59 years, was admitted to the hospital on March 31, 1926, complaining of headache, dizzy spells, and convulsive seizures. He gave a history of two injuries in childhood, with no sequelæ. For the past fifteen years he had had attacks similar to the ones for which he was

admitted, but they had grown worse. The attacks were limited at some times to a short convulsion and at others proceeded to loss of consciousness, varying a good deal, but always starting on the right side. At times, he ground his teeth and bit his tongue. The patient had had a large amount of medication, with no relief, and had lost considerable weight. In 1925 he had had an attack of marked epigastric pain.

The present condition shows nothing unusual except for the subjective symptoms. The family and past histories are irrelevant. Physical examination is entirely negative except for slightly hyperactive knee jerks and slight hyperactivity of some of the other tendon reflexes. The positive findings are that the history suggests a *petit mal*



Fig. 25 (Case 6). Osteitis deformans involving the spine, pelvic bones, and both hips. The changes are the characteristic ones of bone destruction, abnormal bone production, and extensive cystic formation. (Cf. Figs. 23 and 24.)

(Jacksonian epilepsy); slight sluggishness of the right pupil; slight deviation of the tongue to the right; large square head; slight impairment of hearing on right side; marked loss of weight.

X-ray examination of the gastro-intestinal tract shows spasm of the pylorus; otherwise negative. The X-ray examination of the gall bladder is negative. The liver shadow seems to be slightly enlarged. There is definite condensation of the body of the fourth lumbar vertebra, indicating an increased density of the bone due to calcium deposit, which suggests the sclerosing type of carcinoma metastasis. The bones of the skull show marked thickening and mottling, with distinct rounded areas of increased density in both parietal areas; also rarefied areas (Fig. 26). There is a slightly similar process in the right ischium and greater trochanter of the right femur (Fig. 27). These findings are interpreted as osteitis deformans (Paget's disease).

Urinary examination is negative.

Examination of the blood shows: red blood cells 4,256,000; hemoglobin 100 per cent; white cells 6,400; polymorphonuclears



Fig. 26, above (Case 7). Osteitis deformans involving the skull. See text, page 304. Fig. 27, below (Case 7). Note the condensation of the body of the fourth lumbar vertebra. This is a very unusual case and strongly suggests the sclerosing type of metastatic carcinoma seen following carcinoma of the prostate, but the patient was under observation for some time and no primary carcinoma could be discovered. In the face of the radiographic examination of the skull (Fig. 26), a diagnosis of Paget's disease was made.

74 per cent; lymphocytes 24 per cent; Wassermann negative.

During patient's stay in the hospital he has been afebrile. Pulse and respiration are normal.

Summary.—This patient is evidently suffering either from epileptiform attacks or pachymeningitis as there is nothing in his history that would suggest Paget's disease

although the X-ray findings are unquestionably those of Paget's, which probably means that the patient has a complication of these two diseases.

Case 8.—M. W., aged 42 years, married, was admitted to the hospital on July 24, 1924, with the chief complaints of weakness and insomnia. The past history is negative except for attacks of quinsy.

Present illness.—For some three months the patient has been feeling weak and tired all the time. Has gained about five pounds. Insomnia, with headache in posterior portion of head, and pains in both legs have been constant features. In addition, there have been pains in the eyes; also difficulty in going up stairs, with dyspnea on exertion and marked palpitation. The family and personal histories are negative.

Physical examination shows an obese woman who appears chronically ill, with edema under both lids and ptosis of right lid. Irregular pupils. Mouth shows fair teeth and diseased tonsils. Lungs are negative. Heart is rapid; poor muscular tone. Abdomen is negative. Extremities show slight edema of ankles. There seems to be swelling over the left greater trochanter; very slight limitation of flexion; marked limitation of internal rotation; marked tenderness on pressure over trochanters. Patient's posture in erect position is bad.

Laboratory tests.—Urine, negative. Blood count, essentially normal. Wassermann, negative. Basal metabolism, —13. Blood calcium, normal.

This patient has been under constant observation until October 20, 1927. Blood pressure has ranged between a systolic of 110 to 130. On October 15 she reported very marked pain in the toes. On examination, the toes were seen to be shiny and of a bluish-red color, which strongly suggested—both from her description and the

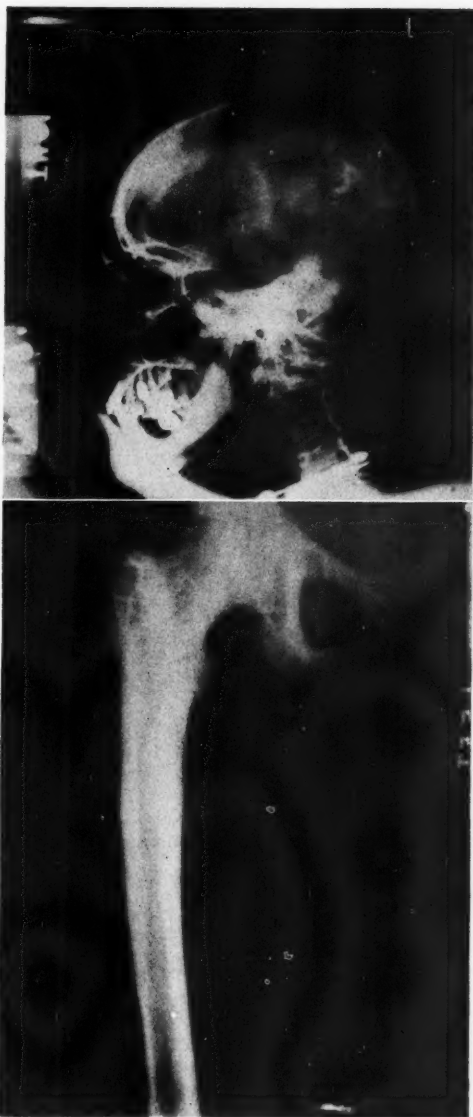


Fig. 28, above (Case 8). Osteitis deformans involving the skull, which shows irregular areas of increased density between the inner and outer tables, more marked in the posterior half. There is considerable thickening, particularly in the occipital region.

Fig. 29, below (Case 8). Osteitis deformans involving the head and greater trochanter of left femur and ischium.

physical findings—a beginning thromboangiitis obliterans.

X-ray examination (Figs. 28 and 29)



Fig. 30 (Case 9). The spine shows marked changes in the region of the first, second, and third lumbar vertebræ; obliteration of the normal outlines of the body, with displacement of the arterial surface, resulting in kyphotic deformity. These vertebræ show very marked osteoporosis, giving a distinctly moth-eaten appearance. This condition extends to the sacrum and to both ilia and pubic bones.



Fig. 31 (Case 9). See text, page 308.

shows a thickening of the cortex of the upper third of the left femur and some anterior bowing. There is a coarse striation in the region of the greater trochanter and neck, with an occasional small area of decreased density. The pubic bones, right ischium and the wing of the right ilium show the same changes. The lumbar spine is negative except for a hypertrophic osteoarthritis. The skull shows irregular areas of increased density between the inner and outer tables, more marked in the posterior half. There is considerable thickening, particularly in the occipital region. The other bones are negative. Diagnosis is osteitis deformans (Paget's disease).

Summary. — The attending physician's note was as follows: "The X-ray examination showed unmistakably the condition in

the left femur, bones of the pelvis, and skull so characteristic of Paget's disease. Patient showed none of the clinical signs of Paget's disease and the age is rather young. It is interesting to note that this patient bears a close resemblance to the myxedema syndrome, in view of the theory that osteitis deformans may result from a calcium imbalance caused by disease of the parathyroid glands."

Case 9.—Mrs. G. H., aged 47 years, admitted on June 30, 1925, to Bloomingdale Hospital. The patient's family and personal histories were negative except for the mental condition for which she was admitted to the hospital.

The present illness dates from 1921, when a spur was noted on the patient's spine.

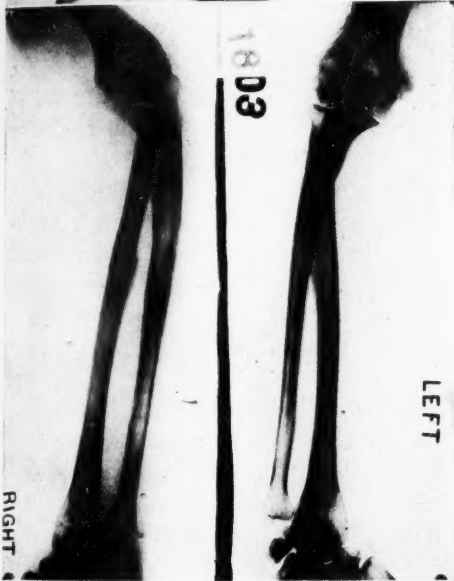


Fig. 32, above (Case 9). The skull shows a slight degree of irregular rarefaction, giving a moth-eaten appearance such as is seen in osteitis.

Fig. 33, below (Case 9).

She was examined by an orthopedic surgeon and he stated that the condition was either tuberculous or due to carcinoma. She was fitted with a spinal jacket, which she wore for a year, at which time she was pronounced well. Six months later it was noted she was becoming round-shouldered. She complained of pain but there was no local



Fig. 34 (Case 9). Showing involvement of the upper ends of the femurs.

irritation. The patient had several Wassermanns taken and all were negative. She attempted to commit suicide by cutting her wrists, and exhibited symptoms of manic depressive. She lost about eight pounds in weight.

Physical examination shows a poorly nourished woman of about 47 years; weight about 100 pounds; face somewhat puffy; color poor. Heart and lungs are negative except for slight cardiac enlargement to the left, with soft systolic murmur; blood pressure 106/50. Slight edema of ankles. Back shows angular deformity in mid and lower thoracic vertebræ. Face rather expressionless. Reflexes slightly exaggerated. Rest of the examination is negative except for slight deformity and slight bending and thickening of the bones of the arms and thighs. Blood count: red blood cells 4,500,000; hemoglobin 60 per cent; white cells 9,950; polymorphonuclears 70 per cent. Blood chemistry shows nothing unusual, with practically normal blood calcium.

X-ray examination of spine (Fig. 30) shows marked changes in region of the first, second, and third lumbar vertebræ; obliteration of the normal outlines of the body, with displacement of the arterial surface, resulting in kyphotic deformity. These vertebræ

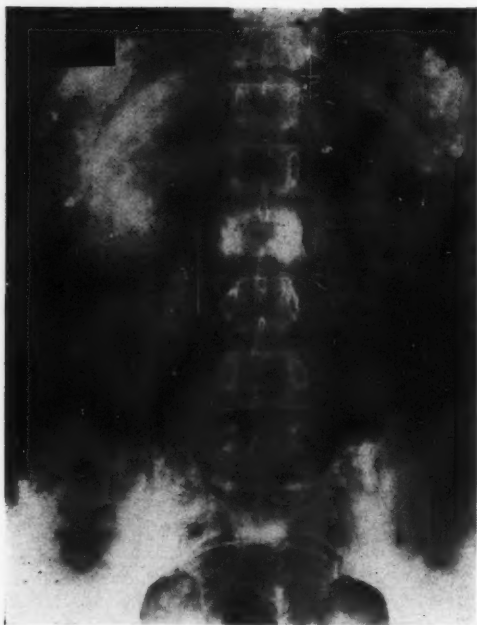


Fig. 35 (Case 10). Showing a definite sclerosing process in the body of the second lumbar vertebra and a sclerosing process, though not as pronounced, with definite mottling and disturbance in the bone trabeculae, in the left ilium.

show very marked osteoporosis, giving a distinctly moth-eaten appearance. This condition extends to the sacrum and to both ilia and pubic bones. The upper ends of the femurs (Fig. 34) are likewise involved. The shafts of the femur and tibia are apparently normal. The right humerus shows some osteoporosis, resulting in a moth-eaten appearance—the osteoporosis along the middle of the shaft. The left humerus (Fig. 31), on the contrary, shows marked defect and throwing up into ridges of the shaft of the bone, with smaller areas of rarefaction in the lower ends of both radius and ulna. The shaft of the radius is fairly normal in appearance, but the shaft of the ulna has the same moth-eaten appearance. The left radius and ulna are only slightly involved. The ribs also show a considerable degree of rarefaction, giving them an irregular moth-eaten appearance.

X-ray examination of chest shows the heart to be triangular in shape, enlarged (especially to the left), with a widening of the arch of the aorta. Apices are poorly illuminated. There is no irregularity of either diaphragm. There is considerable mottling at the roots of both lungs, with considerable increase in the peribronchial tissue.

X-ray of the skull (Fig. 32) shows a slight degree of irregular rarefaction, giving a moth-eaten appearance such as is seen in osteitis.

These findings are diagnosed as due to osteitis deformans. The patient was discharged November 16, 1926, much improved. No further history was obtained.

Summary.—The age at which the onset of disease occurred, namely, 44 years, together with the characteristic X-ray findings, seems to place this case in the classification of osteitis deformans (Paget's disease). The mental symptoms probably have no bearing on the bone disease, though this patient, like Case 4 and Case 5, shows some abnormal brain condition. Three cases, however, do not seem to be sufficient to warrant drawing any definite conclusions.

Case 10.—Mr. K., the patient, was first observed in 1914, and at present is 58 years of age. At the initial X-ray examination a diagnosis was made of small gastric ulcer on the posterior wall, and possibly two small urinary calculi. In 1922, when the patient was again radiographed, the ulcer was not seen and there was a delay in the third portion of the duodenum. A retrocecal chronic appendix was also diagnosed, and gastric retention was noted, interpreted as due to thickening of the pylorus from the old ulcer. In 1927 the patient was seen by Dr. Williams, who elicited the history that in boyhood the patient had had an attack of appendicitis but was not operated on.

Physical examination is negative. The patient suffers moderately from constipation

and has occasional gaseous discomfort, which is relieved by powders. For the past three years he has had irritating pain in the tongue. He smokes a good deal and is rather nervous. Has bad teeth, but they are being attended to. The tongue shows a small induration. He has no symptoms referable to the head; has never had any bone pains or rheumatic pains. His history seems to be entirely gastro-intestinal.

The radiographic examination, done January 20, 1927, shows a definite sclerosing process in the body of the second lumbar vertebra and a sclerosing process, though not as pronounced, with definite mottling and disturbance in the bone trabeculae, is noted in the left ilium, and, to a lesser degree, in the right. The patient's skull has been radiographed and shows the frontal and both parietal bones to be mottled by definite areas of increased density. These areas are irregular in outline. They are not characteristic of bony metastasis, and, when considered in conjunction with the findings in the second lumbar vertebra and in the ilia and sacrum, one's impression would seem to be in favor of a diagnosis of any early Paget's disease.

Summary.—This is another case in which no history, either family or personal, can be elicited to confirm the X-ray diagnosis of Paget's disease, though the changes noted on X-ray examination are so characteristic that there seems to be no doubt (Figs. 35 and 36).

Case 11.—The patient, T. S., aged 63 years, was janitor in an apartment house and came to the Compensation Department because he had fallen and injured his knee while tending the furnace. Physical examination showed thickening of the tibia and slight anterior bowing but X-ray examination showed no evidence of fracture. The changes were interpreted from the X-ray



Fig. 36 (Case 11). Osteitis deformans involving the skull; the frontal and both parietal bones are mottled by definite areas of increased density. These areas are irregular in outline.

findings as due to Paget's disease (Figs. 37 and 38). Unfortunately this patient did not return for X-ray examination of the skull and other bones, and no past history was obtained, so that one includes this case as one of Paget's disease solely on the X-ray diagnosis.

Case 12.—Mrs. E. B., aged 50. This patient entered the hospital May 2, 1927, the chief complaints being loss of weight and weakness.

Present illness.—Patient has noted for the past 18 months a feeling of weakness and of being generally below par. Her friends have noticed an occasional swaying as she walks. She herself has noticed a tendency to deviate to one side, and a desire to put out her hand to steady herself. She occasionally feels light-headed but has only transitory headaches and no other pains. Fifteen months previous to her admission she had a clinical examination in another institution and nothing was found. No X-ray examination was made. She has noticed

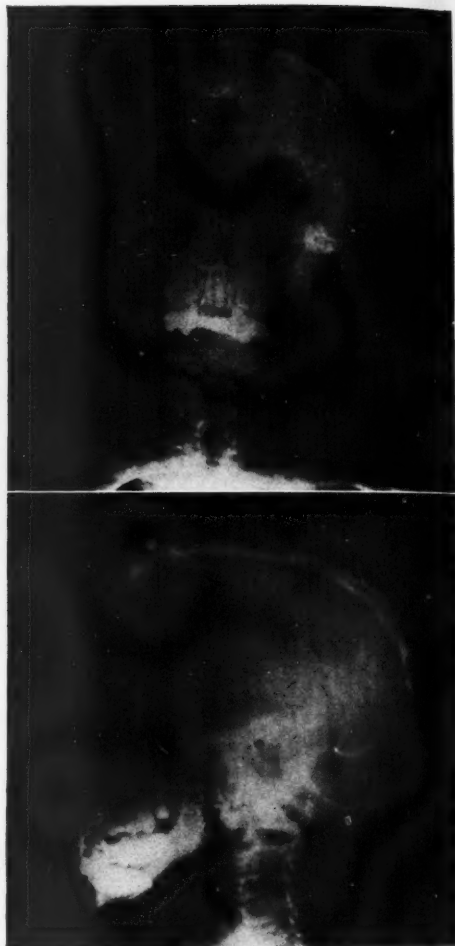


Figs. 37 and 38 (Case 11). Osteitis deformans involves the right tibia, showing characteristic change and extensive calcification of the arteries of the leg. The lesion in this case was localized to this one bone.

an occasional numbness in her hands and weakness in her legs. The past history is negative except for tonsillitis in childhood and swelling of her joints two years ago. The family history is negative except that mother died at the age of 76 years from arteriosclerosis.

Physical examination shows a well developed and nourished adult female, not appearing acutely or chronically ill. She walks with an unsteady gait and shows a tendency to fall toward the right side. The rest of the physical examination is negative except for superficial varicose veins in both legs and definite accentuated tendon reflexes in the biceps, triceps, and knee jerks.

X-ray examination of the skull (Figs. 39 and 40) shows typical irregular dense calcific deposits, with the slight thickening of the outer table which is considered characteristic of Paget's disease. The second lum-



Figs. 39 and 40 (Case 12). Osteitis deformans: note typical abnormal bone deposits and general thickening and enlargement of the bones of the skull and areas of osteoporosis.

bar vertebra, the ilium, pubes, and ischium on both sides showed some deformity; irregular striated appearance and suggestion of cystic formation as the result of osteitis deformans. Gastro-intestinal tract essentially negative (Figs. 41 and 42).

Laboratory examinations.—Red blood cells 4,544,000; hemoglobin 82 per cent; white blood cells 7,200; polymorphonuclears 66 per cent; lymphocytes 33 per cent; Was-

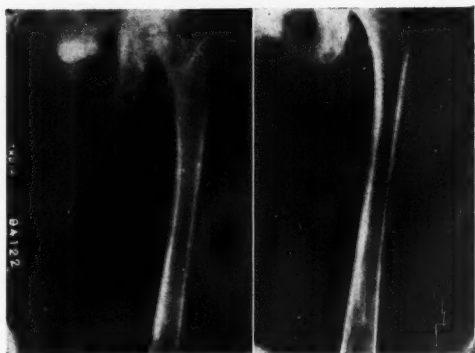
sermann negative; blood sugar 0.11 per cent; blood calcium estimation not made. Urine: no Bence-Jones bodies; negative for sugar and albumin.

Patient was in the hospital for some ten days and showed no other points of interest. The history and the clinical findings were inconclusive, but from the X-ray examination the diagnosis was Paget's disease.

Case 14.—Mr. T., aged 70 years. This patient is included in the series simply for the reason that his right femur and right ilium, ischium, and pubis exhibit the changes which are capable of interpretation as either osteitis deformans or osteitis fibrosa. The history has no bearing whatever on the case. He has always been healthy and the only point which might be regarded as of any significance is that for a number of years he has had what he describes as "twinges of rheumatism," and his knee joints and the articulations of the lumbar vertebrae and the left hip show evidences of an hypertrophic osteo-arthritis. On December 5, 1926, at the age of 69 years, the patient was struck by an automobile, sustaining a fracture of the ninth rib on the right side and a fracture of the neck of the right femur. He was given the usual treatment for the fracture of the femur and was in bed for some twelve weeks. A radiograph taken ten months later still showed the marked osteoporotic lacy appearance of the bone, with the mottling by areas of decreased density, suggesting beginning cystic formation. The skull showed no variations from the normal.

Summary.—Are we to class this patient as a case of osteitis deformans, localized to the ilium, femur, and right ischium and pubis, or are the changes due to marked atrophy of disuse accentuated by the patient's age? The evidence in favor of atrophy of disuse seems rather weak, as the

radiograph made ten months after discharge from the hospital, while the patient was walking some three miles a day in the course of his occupation, still shows the same changes. Frankly, this is unquestionably a



Figs. 41 and 42 (Case 12). Osteitis deformans. See text, page 310.

case which, in the light of our present knowledge, we cannot definitely classify. However, the atrophy of disuse, it seems, can be definitely ruled out on the unilateral distribution of the changes, which would place the condition either in the group of osteitis deformans or in that of osteitis fibrosa cystica.

Case 14.—H. S., aged 57 years. This woman was admitted to the hospital complaining of a chronic illness of about one year's duration. For more than three months she had complained of pain under the right breast and then under the left. She described it as being somewhat superficial in character, the whole area underneath the breast being extremely sensitive to touch. For about a month she had had persistent pain in the lower lumbar region, radiating down to the posterior surface of the left thigh. For the previous three weeks she had had poor appetite, belching of gas, and occasional vomiting. During the three

months' period she had lost about twenty pounds in weight. Prior to the onset of pain and vomiting her symptoms had consisted chiefly in a feeling of general weakness.

X-ray examination, at the time of her admission, of the lumbar and dorsal regions of the spine, including the iliac bones, showed a rather extensive osteo-arthritis (hypertrophic), involving the spine, and, in addition, a partial decalcification of the dorsal and lumbar vertebræ and the iliac bones. Also, there seemed to be a slight osteoporosis of the ribs. At first these findings were thought to be sufficient to explain the pain but they did not explain the patient's loss of appetite and vomiting. She was found to have quite a marked anemia, the red blood cell count being 3,200,000, with 65 per cent hemoglobin, and, at a later date, 4,200,000, with 66 per cent hemoglobin. Examination of the blood smear showed changes characteristic of a secondary anemia, and an explanation was then sought to account for this. Analysis of the gastric contents showed an absence of free hydrochloric acid. The blood Wassermann was negative. The urine was found to contain a trace of albumin and an occasional granular cast. A "red test" was done, which showed 30 per cent excretion of the dye in 2 hours. There was no increase in the blood pressure and the idea that her anemia was caused by nephritis was abandoned. The possibility of multiple myeloma as a cause for the anemia and the bone changes was next considered. The urine gave no Bence-Jones protein reaction and X-ray examination of the long bones showed they were not involved. Further studies of the blood were then made, with the idea that her condition might be due to some derangement of the calcium metabolism, and it was found that her blood calcium was elevated, being 15.3 milligrams per 100 c.c. on September 2.

Five days later the blood calcium was again estimated and found to be 17.1 milligrams per 100 c.c.; again on September 14 it was 18.7 milligrams per 100 c.c. At this time vomiting became a prominent symptom and the patient complained very little of pain from this time on. Her condition at this time suggested malignant disease, with metastasis to the lumbar spine and iliac bones. A careful effort was made to rule this out.

X-ray examination of the chest showed no evidence of metastasis to the lungs.

The general physical examination failed to disclose the presence of a tumor mass in any part of the body. (Pelvic and rectal examinations were repeatedly done, once under an anesthetic, and the findings were entirely negative.) A barium series was done and this showed no evidence of organic disease of the gastro-intestinal tract. A Graham test was done and the gall bladder was seen to be well filled with the dye but angulated at about its center. There were no shadows suggesting stones. The gall bladder, however, did not empty in the usual manner after the taking of food. There was no icterus at any time and examination of the blood serum showed the index to be 5.7 at the time of admission and 4.3 on September 11.

From September 14 on, the patient found it impossible to retain food, fluid, or medication taken by mouth. Vomiting was persistent and accompanied by very little nausea. It was never projectile in type, usually occurring as a regurgitation. The vomitus was usually greenish in color and rarely more than 4 or 5 ounces in amount at any one time. Vomiting almost invariably occurred within an hour after taking anything by mouth, and also at irregular intervals when no food or medication had been taken. Gastric lavage was tried, without benefit.

By September 21 the patient had become

so dehydrated that hypodermoclysis seemed necessary, but, as it was thought that she was still retaining a little fluid taken by mouth, this was not instituted until September 26. Estimation of the blood calcium and phosphorus was done on September 27: calcium 18.2; phosphorus 3.7.

The patient was very weak and appeared even more anemic than her blood count indicated. She was given a transfusion of 800 c.c. of blood by the Lindemann method on October 1; no improvement followed. Blood calcium was 18.6 and phosphorus 2.7 on October 4. Vomiting occurred as before and from this time on she was given fluids (normal saline and 5 per cent glucose in normal saline) by vein, by hypodermoclysis, and by rectum. She very gradually but steadily grew weaker. Her mind remained clear and she apparently suffered very little discomfort.

At this time it was called to the attention of the Staff that a case presenting similar symptoms of vomiting, high blood calcium, and decalcification of the bones, and diagnosed as osteomalacia was markedly benefited by the removal of three of the parathyroid glands (at Bellevue Hospital). As all other measures had failed to benefit the patient, it was decided, with her permission, to perform a similar operation. This was attempted but no parathyroid tissue was obtained and the patient died within 18 hours, after having survived fairly well the immediate effects of the operation. Apparently she had not sufficient resistance to withstand the operative shock. Postmortem examination was not allowed.

X-ray examination of the lower dorsal and lumbar regions of the spine and the ribs and bones of the pelvis showed a marked osteoporosis, giving a mottled lacy appearance to these bones and suggesting marked absorption of the lime salts. The report stated that these findings seemed to

be due to osteomalacia but there was no evidence of multiple myeloma, and the wide distribution, together with the absence of tumor formation and the normal appearance of the outline of the bones, seemed to rule out metastatic carcinoma.

BIBLIOGRAPHY

- ADAMI, J. G.: Principles of Pathology. Lea & Febiger, 1910, I, 401.
- ADAMI, J. G., and McCRAE, JOHN: Text-book of Pathology. Lea & Febiger, 1914, p. 789.
- BAETJER, F. H., and WATERS, C. A.: Injuries and Diseases of the Bones and Joints. P. B. Hoeber, New York, 1921.
- BEADLES, C. F.: *Edin. Med. Jour.*, 1898, III, n. s., p. 388.
- BLOODGOOD, J. C.: *Ann. Surg.*, August, 1910, LII, 163.
- BOWLBY, A. J.: *Trans. Pathol. Soc., London*, 1883, XXXIV, 192.
- CLUTTON, H. H.: *Trans. Pathol. Soc., London*, 1888, XXXIX, 261.
- DA COSTA, J. C.: *Surg. Clin. N. Am.*, February, 1921, No. 1, pp. 54, 55.
- GILLES DE LA TOURETTE and MARINESCO: *Bull. et Mém. de la Soc. Méd. des Hôp. de Paris*, XI, 422, and XII, 789.
- GOODWIN: *London Med. Jour.*, 1785, VI, and 1787, VIII, 67.
- GREENFIELD, J. G.: *Jour. Neurol. and Psychopath.*, August, 1921, II, 116.
- GRIFFITHS, J.: *Trans. Pathol. Soc., London*, 1891, XLII, 249.
- GRUNER, SCRIMGER, and FOSTER: *Arch. Internat. Med.*, 1912, IX, 641.
- HIGBEE and ELLIS: *Jour. Med. Research*, 1911, n. s. XIX, 55.
- HOLMES, G. W., and RUGGLES, H. E.: *Roentgen Interpretation*. Lea & Febiger.
- HUNTER: *London Med. Jour.*, 1787, VIII, 70.
- HURWITZ, S. H.: *Johns Hopkins Hosp. Bull.*, September, 1913, XXIV, 263.
- LAMBERT: *Bull. of Committee for Study of Special Diseases*, II, Chap. XXII, 75.
- LEWIN, PHILIP: *Jour. Bone and Joint Surg.*, 1922, IV, 51.
- LUNN, JOHN R.: *Trans. Clin. Soc., London*, 1885, XVIII, 272.
- MACKENZIE, HECTOR W. G.: *Trans. Clin. Soc., London*, 1896, XXIX, 245.
- MACKENZIE, STEPHEN: *Ibid.*, 1885, XVIII, 331.
- OETTINGER and LAFONT: *Nouvelle iconographie de la Salpêtrière*, 1905, XVIII, 292.
- PACKARD, F. A., STEELE, J. D., and KIRKBRIDE, T. S.: *Am. Jour. Med. Sci.*, 1901, CXXII, 552.
- PAGET, SIR JAMES: *Brit. Med. Jour.*, Dec. 16, 1882, p. 1189.
- Idem: *Trans. Med.-Chir. Soc., London*, 1877, LX, 37.

- Idem: Trans. Med.-Chir. Soc., London, LXV, 225.
 PRINCE, MORTON: Am. Jour. Med. Sci., 1902, CXXIV, 796.
 St. Thomas's Hosp. Museum, No. 415B.
 SYMONDS, C. J.: Guy's Hosp. Rep., 1881, Ser. 3, XXV, 99.
 TUBBY, A. H.: Deformities, Including Diseases of the Bones and Joints. Macmillan & Co., London, 1912, II, 569.
- WATSON, W. T.: Johns Hopkins Hosp. Bull., 1898, IX, 133.
 WHERRY, GEORGE: Brit. Med. Jour., Sept. 19, 1896, No. 1864, p. 743.
 WILKS: Trans. Pathol. Soc., London, 1869, XX, 273.
 WYLLIE, W. G.: Brain, October, 1923, XLVI, 336.
 ZIEGLER, E.: Text-book of Pathological Anatomy and Pathogenesis, trans., 3rd ed., 1896, I, 149.

Regarding the Point of Attack of the Roentgen-ray Effect on the Biological Object. An Experimental Study Regarding the Analysis of the Phenomenon of the Effect of Roentgen Rays upon the Blood Sugar. J. Rother. Strahlentherapie, 1927, XXVII, 197.

The author has undertaken an extensive study of the blood sugar changes following irradiation. It is impossible to give in an abstract a detailed account of this important work, which is recommended for study in the original. However, some of his conclusions may be quoted. In dogs, guinea pigs and rabbits, marked increase in the blood sugar is observed following a heavy X-ray exposure of the upper abdomen. Within one to one and a half hours the blood sugar content rises from 0.1 to 0.17 and 0.19 per cent, decreasing slowly afterwards. Control experiments proved that this effect was due to roentgen rays. The sugar evidently comes from the liver, the glycogen content of which is decreased following the exposure. Experiments

on isolated surviving liver tissue *in vitro* did not reveal an effect of roentgen rays on the sugar formation. The same holds true for liver extra-corporeal with artificial circulation. In the organism the blood sugar will not rise if both nervi splanchnici have been severed. Injections of ergotamin have the same effect. All connections with the autonomic nerve system have to be intact, therefore, in order to produce a "radiation hyperglycemia." These functional changes were not supported by histological findings in the liver. The animals died usually about five days following the applied dose. The observations were the same regardless of whether the liver or the lower abdomen had been irradiated. It is assumed, therefore, that toxic materials are formed in the intestinal tract during irradiation, taken up by the blood and lymph stream, and so cause the described changes. Besides the possibility that some decay product formed during the exposure causes the hyperglycemia, one may consider changes in the colloid-electrolyte system.

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OSTEOCHONDRITIS DISSECANS¹

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THE observation of several cases of osteochondritis in rather unusual sites is the basis for the résumé of this entity. The first description of this type of loose body was by Franz Koenig, in 1888. When he described the segregation of a portion of cartilaginous and subchondral tissue into the joint space, giving it the name "osteochondritis dissecans," he suggested that it might be the result of a low grade infectious process. The condition is not unusual—indeed far from rare—as numerous reports of cases are found in the literature, particularly since 1910, when Freiberg and Wooley described the process in the English literature.

The most commonly reported sites of the process are in the external condyle of the humerus and the lateral portion of the mesial condyle of the femur, the patella being mentioned in a few cases. It occurs chiefly in males of young adult age, although it has often been noted in young adolescents, particularly by Panner. Although Koenig mentioned several cases of loose bodies in the hip joint and ascribed the etiology to osteochondritis dissecans, Phemister has drawn attention to the fact that in several of these cases the head was detached from the neck near the region of the epiphyseal line and that this is not the site of separation in loose bodies of this classification.

As regards the etiology there is considerable diversity of opinion. Although the roentgen examination has afforded a valuable means of observing the development and progress of the lesion, it has not afforded an explanation as to the cause. Barth was one of the earliest writers who regarded the condition, not as the result of a disease

named osteochondritis dissecans by Koenig, but as a pathological process definitely the result of trauma. The lack of a definitely traumatic history in many cases and the occasional occurrence of a bilateral case, has inspired a great many theories to explain the characteristic separation of the fragments from a free articular surface. Barth felt that the pull of ligaments at their insertion was a common cause of the condition. Kappis believed that the knee and elbow, due to their anatomical resemblance, were predisposed to a traumatic fissure of the cartilage and this resulted in a lesion of the convex articular surface.

Freiberg offers another theory. He believes that the occurrence of a long tubercle on the mesial tibial spine in a position of flexion and external rotation of the tibia or the femur results in a localized trauma to an arteriole in the mesial femoral condyle. Colvin takes a different view and has demonstrated the presence of capillaries in the fibro-cartilage, which have grown after detachment of the fragment. He believes that this indicates a vital process. He believes that the production of fibro-cartilage along the line of cleavage causes the fragment to bulge toward the joint and finally fracture, the thin hyalin plate holding it in place. He feels that the process is infectious and describes the cavity after separation as having a raw, bleeding surface, like granulation tissue, and thinks the induration of surrounding subchondral bone the result of sclerotic change following infection. Bernstein believes that the process may be a constitutional disease involving the ends of long bones and that a hereditary factor is probably present. He reports three cases in the same family, one brother and two sisters. In all three cases the knee was involved, and,

¹Read before the Radiological Society of North America, at the Thirteenth Annual Meeting, at New Orleans, La., Nov. 29, 1927.

in the brother, loose bodies were found in both knees.

The roentgen findings are quite typical. An area of rarefaction of varying size is seen in the subchondral region of the in-

degenerative and regenerative changes go on in it, both while it is attached by a pedicle and after it is liberated in the joint. While attached by a pedicle, it may be nourished through blood vessels and the degenerative

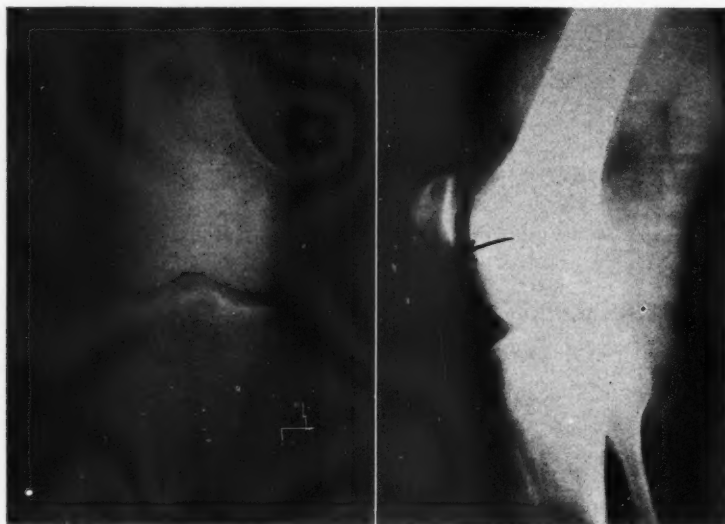


Fig. 1 (Case 1). Osteochondritis dissecans of patella.

involved site. This, Panner explains, is the result of injury to cartilage at this site and the bone absorption is similar to that occurring about minute fissure fractures of the diaphyses and in the os navicular, which are often not visible immediately after injury, but appear after absorption of osseous tissue in the immediate zone of trauma. The separated fragment may contain no osseous tissue and, unless separated for a long enough time for secondary changes of calcification and ossification to have developed, will not be seen in the roentgenogram. In some cases a subchondral defect will be noted on the film, but surgical exploration will reveal merely a discoloration of cartilage, the process not having progressed to separation, but presenting the same roentgen findings.

Phemister describes the pathology as follows: "After the body has become loosened,

changes may be slight. However, both cartilage and bone tend to gradual necrosis. Proliferative changes may be considerable during this period. They consist mainly in the formation of fibro-cartilage along the surface of separation, but, where bone is present, there may be also considerable new bone formation. After complete separation in the joint, all bone which has had a blood vascular circulation becomes necrotic and there is still further necrosis and calcification in the articular cartilage. However, the fibro-cartilage and fibrous tissue along the surface of separation receive sufficient nutrition from the synovial fluid and proliferate, causing a slow increase in the size of the body."

CASE REPORTS

Case 1. This patient was referred by Dr. Atsatt, with a clinical diagnosis of osteo-

chondritis dissecans of the right knee, with separation of the fragment. Patient complained of pain and stiffness in the right knee. Thirteen days before, he had been playing baseball and was struck directly on the knee by a player diving for his base. Swelling and dull pain were noted after the injury, but on the tenth day after the accident, a sharp pain, with locking of the knee, occurred. After unlocking of the joint, the patient noted a small, freely movable lump on the mesial aspect of the knee. Roentgenograms of the knee failed to reveal a loose body, the articular surfaces of the tibia and femur presenting no irregularity. The symptoms of pain and locking persisted and the patient submitted to operation five days later. Dr. Atsatt's report is: "The loose body could not be located before operation, so a median, parapatellar incision, 12 cm. in length, was made. Patella was retracted laterally and the median aspect of the knee explored, using long grasping forceps and external manipulation. External pouch similarly explored and the loose body obtained. It measured $14 \times 8 \times 4$ mm., and was a roughly rectangular concave-convex piece of cartilage with sharp edges, covered on the concave side with a layer of synovial membrane. This membrane projected be-

yond the limits of the cartilage along one side as though there had been a 'V'-shaped tear in the adjoining tissue. The convex side was roughened but macroscopically contained no bone fragments. Unfortunately the piece of tissue was lost in the laboratory, so no microscopic study was possible.

"The defect in the patella was located in the mesial articular facet, near the distal border. The edges of this defect were rounded and the base was 'hillocky' in appearance, as though the regeneration of cartilage was proceeding unevenly. The defect was about one-third filled with fibrocartilage. The synovial membrane of the joint was only slightly injected and not appreciably thickened. There was a slightly increased amount of fluid, but, on the whole, the knee joint was in good condition."

This represents a loose joint body, the source and development of which closely resemble the process described as osteochondritis dissecans. The etiology is clearly traumatic and the pathology typical of this type of loose joint body. A re-examination of the roentgenograms, made before, revealed a small, oval defect in the lower portion of the patella which had been completely overlooked. Moschowitz reports a similar



Fig. 2 (Case 2). Osteochondritis dissecans of knee, showing defect in external condyle, with fragment *in situ*.

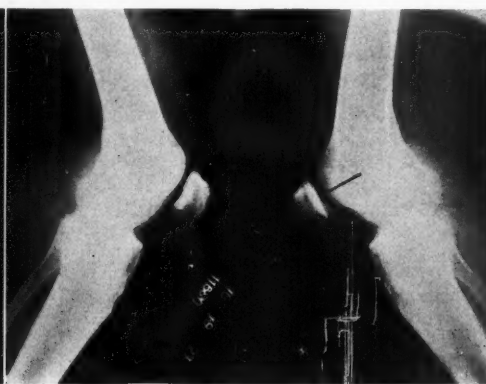


Fig. 3 (Case 2). Osteochondritis dissecans (right knee), showing patella and lateral condyle of femur.

case of a loose body originating from the patella, which presented a similar roentgen appearance. Phemister states that the patella is an occasional source of loose body and cites one case.

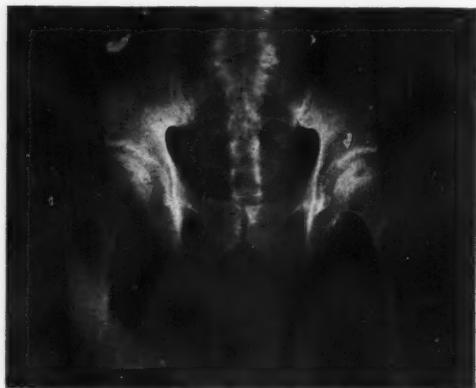


Fig. 4 (Case 3). Osteochondritis dissecans of hip.

Case 2. A nurse 27 years old was referred for roentgenograms of the right knee. Her history was that of intermittent periods of pain in the knee, with occasional locking of the joint. The first locking had occurred when she was 12 years old and she could not remember definite trauma previous to that time. Roentgenograms reveal a defect in the lateral portion of the external condyle of the femur, in which lies an oval fragment of bone, apparently almost completely separated from the condyle. The patella shows a small defect on its posterior surface. No loose bodies are visualized, although, clinically, palpation reveals a small loose body. This in all probability is the fragment which separated from the patella.

Case 3. I wish to thank Dr. R. G. Allison for the privilege of reporting the following case. A young farmer 29 years of age was referred for roentgen examination of the left hip. He complained that mild pain had been present in this hip since the age of 16. In the weeks preceding examination, he had

suffered several attacks of severe pain, with locking of the joint. These symptoms occurred late in the plowing season, during which, the patient stated, he always walked behind the plow. Roentgenograms revealed a rather large area of subchondral rarefaction in the head of the femur. The margin of this rarefied area showed a definite increase in density. Within this cavity lay an apparently completely separated bony fragment. The head of the femur, except for this defect, was of normal contour, ruling against the possibility of an old Legg-Perthes disease. The history was also against this disease as the etiology.

Case 4. Patient was a young man 22 years old, referred by Dr. Spaulding for examination of the left elbow following an injury received while playing football. Roentgenograms show a defect in the external condyle of the humerus, in which lies a small oval, bony fragment, apparently entirely separated from the rest of the condyle. The lateral view reveals another bony fragment just behind the external condyle and lying free in the joint space. An irregularity on the posterior surface of the external condyle apparently conforms to the size and shape of this fragment.

A fine intra-articular fissure is noted through a portion of the radial head. The history is that of an injury six years previous to the recent one. While playing soccer, the patient had fallen with arm outstretched. Complete recovery followed a short period during which the arm was not used. Several days before the recent examination, the patient suffered a similar injury while playing football and roentgen examination revealed the loose bodies and the recent fissure fracture of the radius.

CONCLUSIONS

(1) The occurrence of that type of loose joint body known as osteochondritis dis-

secans is not restricted to the knee and elbow joint. In the knee joint it may occur in sites other than the mesial femoral condyle, although this is the favored site.

- (5) MOSCHCOWITZ, A.: Osteochondritis of Patella. *Ann. Surg.*, LXXX, 794 (Trans. N. Y. Surg. Soc., May 14, 1924).
- (6) FREIBERG, ALBERT H.: Osteochondritis Dissecans. *Jour. Bone and Joint Surg.*, January, 1923, V, 3.

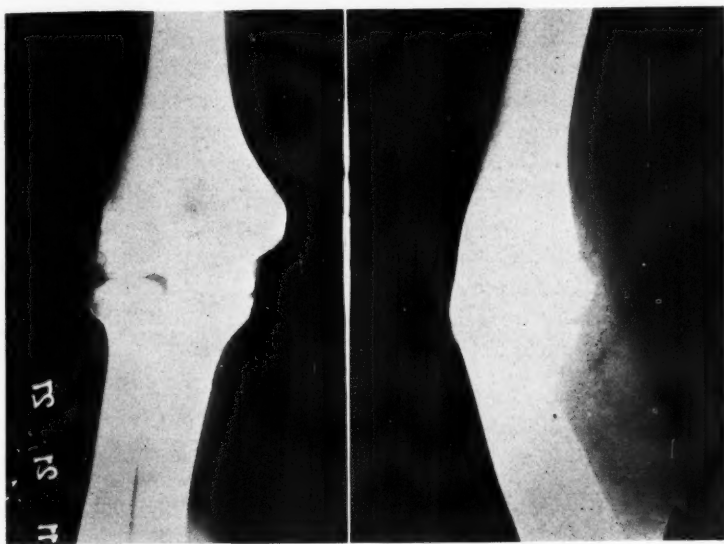


Fig. 5 (Case 4). Osteochondritis dissecans of elbow, showing two fragments separated from external condyle.

- (2) The process is usually on a definitely traumatic basis.
- (3) The roentgen findings are uniformly typical, consisting of subarticular defects present in all cases, with or without visualization of the loosened fragment.

- (7) KAUFMANN, E.: *Pathologischen Anatomie*.
- (8) KOEHLER, A.: Grenzen des normalen und anfänge des pathologischen im röntgenbilde, 1924, pp. 49 and 142.
- (9) FISHER, A. G. T.: Loose Bodies in Joints. *Brit. Jour. Surg.*, April, 1921, VIII, 493.
- (10) KAPPIS, M.: *Deutsch. Ztschr. f. Chir.*, 1920, CLVII, 214.

REFERENCES

- (1) PHEMISTER, D. B.: The Causes of and Changes in Loose Bodies Arising from the Articular Surface of the Joint. *Jour. Bone and Joint Surg.*, April, 1924, VI, 278.
- (2) PANNER, H. J.: Separations from the Capitulum Humeri as the Most Frequent Determining Cause of Arthritis Deformans Cubiti. *Acta Radiol.*, III, Fasc. 2-3, 2:VI, 1924.
- (3) COLVIN, A. R.: The Clinical Course and Pathology of an Obscure Ostitis Causing Loose Bodies in Joints. *Minn. Med.*, February, 1920, III, 65.
- (4) BALENSWEIG, I.: Osteochondritis Dissecans of the Knee. *Jour. Bone and Joint Surg.*, April, 1925, VII, 465.

DISCUSSION

DR. LEWIS GREGORY COLE (New York City): The examination of the case just reported was originally made by Dr. Allison, or rather, the original plates were made by Dr. Allison, of Minneapolis. Subsequently we made a series of plates of all parts of the body and I was unable to make a diagnosis, bearing in mind the fact that this is the very type of disease which we have seen illustrated in all forms of all

stages and which has been considered to be one of adult life.

I think that brings in the most important point of the talks that have been made here. The whole gist of the thing is that we are wasting time trying to make all of these hair-line classifications, because, so far as I can see, they do no good. I cannot see that there is any real, definite division between all of these types of disease that have been presented. Paget discovered these things and his name was given to them. Later some one else comes along and includes in the set of chronic bone diseases the same type of lesions that Paget discovered. He goes into it a little more liberally, and gives them descriptive names, but generally Paget's name is attached to the group of chronic bone diseases. I have tried my best throughout this discussion to find out what differences there may be which really exist between these bone diseases and why these classifications were attempted. It is a chronic bone destruction and production, yet the principal thing we have brought out is a study of classifications that will do us practically no good, and, if so, the only practical point would be to treat for these diseases in infancy. I do not believe any treatment does them any good. No one said anything about treatment. Something should be said about that and perhaps we would learn something.

I am as much in favor of classification of diseases as any one, provided the classification is going to be of any practical value either in the study or prognosis or treatment of the disease.

DR. M. J. GEYMAN (closing): I merely wish to emphasize the fact that osteochondritis dissecans may occur in other sites than

the external condyle of the humerus and the lateral portion of the mesial femoral condyle, which are the usual types reported. Any part of the knee or elbow joint and rarely the hip may be the source for this type of loose body.

DR. W. W. BELDEN (closing): In answering Dr. Cole about the classification, permit me to say that I am very glad that he brought this out because the classification was submitted in the hope that an argument might be started. I heartily agree with him that none of us knows anything definite in regard to these baffling bone diseases, and it is only by discussing them and interchanging ideas that one can arrive at any definite concrete knowledge.

As stated in my paper, I feel that osteitis deformans and osteitis fibrosa cystica are the same disease; that the latter is the manifestation of Paget's disease in the young and what we call Paget's disease is a similar reaction in the adult past middle life. There is evidence, especially in the general form of osteitis fibrosa cystica, with the involvement of numerous bones, to suggest that it, with Paget's disease, is one of those obscure disorders of calcium metabolism and ossification, along with which may be included osteomalacia, achondroplasia, rickets, and hereditary deforming chondrodysplasia.

It is hoped that more discussion will be started by this classification, and, as stated previously, there is nothing that will please the author more than the formation of a registration to study these baffling bone conditions from the many aspects—pathologic, clinical, and radiographic. Let me make a plea in closing that we get together and try to do something to increase our knowledge of these conditions.

RADIOTHERAPY IN ACTINOMYCOSIS¹

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ACTINOMYCOSIS is a chronic infectious disease produced by the ray-fungus. *Streptothrix actinomyces*, and characterized by infiltrative or suppurative lesions in the subcutaneous tissues of the head and neck, in the submucous tissues of the mouth and tongue, in the digestive or respiratory tracts, and sometimes even in the brain and liver. New and Figi published a series of 157 cases, in more than 68 per cent of which the head and neck were involved. The clinical features and the course of the disease may vary greatly; its characteristic aspect is that of a small or large indurated mass, which subsequently breaks down and forms multiple abscesses. The mass may appear as a small nodule beneath the skin or mucosa or as a large, firm, and diffuse tumefaction, and its progress may be rapid or slow and indolent. When fully developed the disease is essentially pyemia.

ETIOLOGY

Ever since Ponfick established the identity of the disease in cattle and in man, infection in the latter has been generally attributed to contagion from the lower animals. This has often been questioned and it is difficult in many cases to prove such a connection; it probably means that direct contagion from animals is uncommon and that in most cases the infection is indirect. New and Figi have obtained evidence of indirect infection in the form of "dental caries, picking decayed teeth with straws, or chewing bits of straw or grass." A definite history of trauma and foreign body was secured in five cases. In six other cases the

onset of the disease followed immediately on the extraction of teeth. The digestive tract is by far the most common pathway of infection.

SYMPTOMS

The symptoms depend on the site of the original lesion and on the form of the disease. When it first invades the skin of the head or neck, or the oral mucous membrane, the clinical manifestations may consist in stiffness, pain, and swelling in the affected region. The pain is often severe and throbbing, but it may be slight or absent at the outset. Soreness of the throat, stiffness of the neck, earache, dysphagia or dyspnea may occur, according as the base of the tongue or the hypopharynx and epiglottis are involved.

Pulmonary infection is usually unilateral and is accompanied by cough, fever, loss of weight and strength, and mucopurulent expectoration. Abscesses and cavities may form, and erosion of vertebrae, ribs, or sternum may be encountered in certain cases. The symptoms sometimes suggest tuberculosis. Infection of the intestine may be primary or secondary, and the region of the cecum and appendix is the most common seat of the disease; it may simulate appendicitis, for which it is often mistaken. Irregular fever, and loss of weight and strength are frequent manifestations but the fever depends on the extent and degree of the suppurative process. Occasionally the course of the disease may resemble that of typhoid fever, at least for a time.

PATHOLOGY

According to Askanazy, proliferation of the fungus within the tissues calls forth a chronic productive inflammatory reaction

¹Read before the Radiological Society of North America, at New Orleans, Louisiana, Nov. 28-Dec. 2, 1927.

which may or may not rapidly undergo supuration. At the outset the inflammation is circumscribed and appears as a small yellow granule or cluster of granules, and it is this rather characteristic appearance which has given rise to the expression, "the sulphur granules of actinomycosis." At the outset, however, before fatty degeneration has occurred, the granules or nodules may appear gray. The lesions may suppurate early or they may occur as a firm diffuse infiltration and give the impression of cellulitis or of tumor. The tendency of the lesions to progress more or less steadily, to suppurate and to erode the adjacent tissues often causes death by rupture into serous cavities. The suppurating lesions may drain by breaking through to the surface and forming sinuses which may continue to discharge continuously or intermittently for a long time.

The essential lesion of actinomycosis consists of a central clump of *Actinomyces* around which an inflammatory reaction develops in the form of vascular granulating tissue with marked leukocytic infiltration. As the process increases a zone of fibrous connective tissue develops around the periphery of the lesion, and giant cells may sometimes be found in this zone. At the same time the granulation tissue surrounding the fungi undergoes fatty degeneration, disintegrates and forms an abscess the pus of which is bright yellow. Other similar lesions form nearby; the lesions coalesce and in this manner larger and larger abscesses form, until, by erosion into blood vessels or into a serous cavity, metastasis to the lungs, brain, or liver, or peritoneal or pleural dissemination occurs. When the process invades the intestine it first appears as small nodules in the mucosa and submucosa; these ulcerate and cause more or less extensive adhesion of intestinal loops or perforate the bowel and cause fecal abscesses, infiltration of the abdominal wall,

or rupture through the skin. The lymph nodes rarely become involved. According to MacCallum, "The infection burrows through the tissues for great distances, completely distorting whatever it traverses, and it stops for nothing: bones are penetrated as easily as muscles, and from the lung such a mine-like advance may push through the pericardium and heart wall into the interior of the heart."

DIAGNOSIS

Recognition of the disease depends on the clinical picture, the presence and identification of the characteristic granules, and the microscopic demonstration of *Actinomyces* in the exudate or discharge. The clinical aspect may be masked by secondary infection, and revelation of the true character of the lesions may require repeated examinations and protracted observation. The possibility of such infection is often overlooked and this undoubtedly explains why so many cases are mistaken for tuberculosis or other infection, such as simple appendicitis. The chronic progressive character of the condition should arouse suspicion; unfortunately, many cases go unrecognized for a long time.

The incongruous colloquial expression "lumpy jaw" might imply that the disease affects chiefly the jaw-bone, but this is not the case. While the bone may sometimes be invaded, the condition starts in the soft tissues underlying the mucosa or skin when the disease is situated around the head or neck, and it must be distinguished from simple cellulitis, tuberculous or syphilitic adenitis, and lymphoblastomatous or metastatic adenopathy. The differential diagnosis may be complicated by cerebral, pulmonary, or intestinal invasion.

TREATMENT

Various forms of treatment have been employed. It has long been held that the internal use of iodides exercises a specific

influence on the lesions of actinomycosis, but this can hardly be true, because, while the iodides may cause more or less improvement, they cure in but few cases. If, as certain authors have claimed, the iodides constitute a specific remedy for actinomycosis, no other method of treatment should be required. Unfortunately, the results of treatment by iodides have not been satisfactory, and the medical profession has continued to seek a more effective means of combating this dreadful malady. The same may be said of surgery, which, although useful or even indispensable in some cases, is seldom adequate to bring about cure and sometimes only serves to disseminate the disease. One has but to read the many cases reported in the literature to become convinced of this; many of the patients concerned had been operated on several times and yet the condition extended more and more after each intervention. Such common failure of surgical measures in the past may have been partly due to inaccurate diagnosis and consequently to unsound surgical technic; however, there have been many cases in which a correct diagnosis had been made but surgical treatment was, nevertheless, unsuccessful.

Harsha (1904) was apparently the first to employ roentgen irradiation successfully in the case of a man aged fifty years, having a swelling at the angle of the right jaw, which had developed after the extraction of two teeth and which had been previously regarded as sarcoma. The mass had been incised, but the wound did not heal until after roentgen-ray treatment was combined with potassium iodide by mouth. The wound then healed, the swelling disappeared, and the patient remained well. Pusey (1904) reported one case of probable, but not proved, actinomycosis, in which the lesion disappeared completely under roentgen-ray treatment. Bevan (1905) recorded six cases, in several of which there were ad-

vanced abdominal or pulmonary lesions. Five of the patients showed considerable improvement after roentgen irradiation and the internal administration of iodides. Zeisler (1906) described the case of a young woman aged twenty-four, who had acquired the habit of chewing grain while playing golf. A painful swelling developed in the submental region which was lanced twice by her physician, but which continued to spread. The disease subsided rapidly and completely after treatment by roentgen rays, hot fomentations, iodine externally, and iodide and copper sulphate internally.

Iselin (1910) called attention to the rapid regression of actinomycotic swellings and infiltrations after roentgen irradiation. Levy (1913) recorded the interesting case of a man, aged forty-two, having extensive suppurative actinomycosis of the floor of the mouth and tongue, who did not derive benefit from iodides, but whose lesions disappeared rapidly after exposure to roentgen rays. Levy described a second case (that of a man aged thirty-five), having extensive actinomycosis of the cheek and upper jaw with dense infiltration and multiple sinuses. The lesions regressed completely only after roentgen-ray treatment and had not recurred one and a half years later. Sarde-mann (1914) reported four cases in which cure was effected by roentgen irradiation, surgical treatment, and administration of iodides, but credited the result chiefly to irradiation.

Since then many other cases showing the striking effectiveness of roentgen rays against actinomycotic lesions have been recorded by Brunzel (1915); Pordes (1916); Melchior (1916); Harris (1916); Rosing (1916); von Bergen (1916); Kaarsberg (1916); Wickhoff (1917); Jensen and Schery (1920), and many others. In some of these cases several operations had been performed fruitlessly before roentgen-ray treatment was resorted to successfully.

Heyendahl (1916) reported several cases in which the actinomycotic lesions were cured by means of radium. New and Figi (1923) published an extensive study of 107 cases of actinomycosis of the head and neck and stated that treatment by means of radium, potassium iodide in large doses, and thorough drainage of purulent collections had caused the actinomycotic process to disappear in all but the advanced cases in which there was extension to the meninges or thorax.

One cannot review this clinical evidence and scrutinize the reports of all these proved cases of actinomycosis without concluding that the chief factor in improvement and cure was, not surgical procedures or the iodides, but irradiation. I do not intend to imply that surgical intervention and the use of iodides are never indicated. On the contrary, both appear distinctly useful, but, as New and Figi have justly pointed out, "the most important factor in obtaining good results in the treatment of actinomycosis is an early diagnosis. In the early cases the patients all do well." It is probable that, during the early stage of the lesions, before central suppuration has occurred, thorough treatment with roentgen or radium rays would be sufficient to put an end to the infection. Irradiation is effective against lesions of the head and neck even when attended by suppuration.

The importance of early diagnosis is especially great in cases of actinomycosis of the intestine or lungs. Unfortunately, these are the cases in which diagnosis is most difficult and in which the patients often receive treatment for other conditions a long time before the true character of the disease is suspected or established.

Approximately thirty proved cases of intra-abdominal or intrathoracic actinomycosis were observed at the Mayo Clinic between 1920 and 1925. Nineteen of the patients were males, and ten were females. The

average age of the males was thirty-four and a half years, with extremes of fourteen and fifty-five years. The average age of the females was twenty-nine and one-tenth years.

In twenty-six cases the disease affected chiefly the intestinal or pelvic structures or both. The pulmonary apparatus or thoracic structures were the principal seat of the disease in eleven cases, and in seven the lesions were in both the thorax and the abdomen.

Table I shows the chief symptoms of the disease as obtained from the history, the presenting lesions at the time of registration at the Clinic, and the antecedent treatment. From this it will be seen that, of the twenty-two cases in which the initial symptoms were related to the abdomen, in sixteen simple appendectomy or drainage of a so-called appendiceal abscess had been carried out, and in two of those drainage of pelvic abscesses also, without the character of the lesions having been recognized. In one of these cases the symptoms of appendiceal inflammation started soon after herniotomy, and it is permissible to surmise that the lesion which led to this operation may have been related to the actinomycotic process.

As is shown in Table I, the lesions were extensive in most of the cases and it is not surprising that so many of the patients died. Indeed, it is surprising that a larger number have not died and that the condition of several has improved substantially under irradiation. This number would undoubtedly have been still larger if more of them had received early, thorough, and systematic treatment. Moreover, the degree of improvement observed in fourteen cases, in some of which death occurred later, has been roughly proportional to the faithfulness with which the treatment has been carried out, in spite of the advanced stage of the disease, in many instances, when the treatment was instituted. Drainage of purulent collections

under tension and causing fever often had to be resorted to at the outset or later. Table II shows the general scheme of treatment and the result in each case.

The treatment in most cases consisted of a combination of drainage, the administration of iodides internally, and roentgen irradiation of the abdomen or thorax. Radium treatment was also given in eight cases at some time during the subsequent course of the disease. In eleven cases drainage or any other surgical intervention was not required.

If the lesion was situated in the abdomen, roentgen rays were applied from the level of the xiphoid cartilage to that of the lower border of the pubis, generally through four anterior and four posterior fields. The rays were always generated at about 135 peak kilovolts, the focal-skin distance usually was 16 inches, and the intensity of the current flowing through the Universal Coolidge tube was 5 milliamperes. Each of the anterior abdominal fields was treated with the rays filtered through 4 mm. of aluminium, and the posterior fields with rays filtered through 6 mm. of aluminium. Such a course was repeated several times at intervals of three or four weeks; or, if the patients could not return to the Clinic for such treatment, they were instructed to arrange for it with a roentgenologist near their home. Improvement was not always immediate and sometimes distinct improvement was not noted until after the second or third course of treatment. Unfortunately, many patients were so ill and the lesions were so extensive when the treatment was started that the termination must necessarily be fatal. In other instances, the patients, for various reasons, failed to follow instructions.

It is probable that drainage alone or in conjunction with the use of iodides may have influenced the subsequent improvement of some of the patients; but, in view of the well known influence of irradiation on actinomycotic processes, it is likely that the chief

factor in the improvement noted in some of these cases must be credited to irradiation.

To show that this is not a vain claim and that roentgen irradiation has a potent influence on actinomycosis, the following case is presented.

A school boy, aged seventeen, registered at the Mayo Clinic March 24, 1926. He had been operated on at home in April, 1925, supposedly for simple acute appendicitis with perforation. He regained weight, resumed work on the farm, and apparently remained well for four months, although the wound continued to drain slightly. Late in December the drainage from the wound stopped for ten days and he became acutely ill; the temperature was 102° F. He was taken to a nearby hospital, again operated on, and the parents were told that the omentum was gangrenous. Three weeks later pain developed in the left side of the abdomen, he again became quite ill, and was subjected to a third operation, which revealed an intra-abdominal abscess. The two last incisions discharged purulent material, but this diminished slowly. Two subcutaneous abscesses near the root of the penis appeared about three weeks before the patient's arrival at the Clinic; these also were incised and healed. About March 18, 1926, pain developed in the left side of the back, increased in severity, radiated to the upper part of the abdomen anteriorly, and was accompanied by slight fever and continuous vomiting for two days. The pain had subsided slightly and the vomiting had ceased when he arrived at the Clinic. He had lost from twenty-five to thirty pounds in weight.

On examination, the boy was moderately emaciated and pale. Incisions in the anterior abdominal wall over the right and the left rectus muscles exuded a small quantity of purulent material. There was definite tenderness on palpation of the upper left abdominal quadrant, and moderate distention. The hemoglobin was 47 per cent,

TABLE I.—SYMPTOMS, PRESENTING LESIONS, AND ANTECEDENT TREATMENT

Case	Symptoms	Presenting lesions	Antecedent treatment	Survival after registration
1	Pain in abdomen for two and one half years. Fever and vomiting.	Profusely draining abdominal sinuses.	Many incisions to improve drainage.	Died four years later.
2	Sensation of tightness in chest six months before.	Discharging sinus over sternum.	Incision of initial lump as abscess; plasters.	Died two years later.
3	Attacks of abdominal pain for four years. Later pain in right groin.	Tumor and sinuses in right groin.	Exploratory laparotomy; appendectomy; drainage.	
4	Pain in abdomen for one month; pain in left groin.	Sinus in left groin.	Exploratory laparotomy; drainage. Diagnosed as inoperable carcinoma.	Condition improved four and one-half years. Recurrence.
5	Pain in abdomen and fever for two years.	Tender mass in abdomen, with sinuses.	Operation for "ruptured appendix."	Died seven months later.
6		Abscesses, thoracic and abdominal.	Incision, drainage and resection of ribs twelve years before.	Died two years and eight months later.
7	Appendicitis six months before; then pleurisy.	Draining sinus in right thorax.	Appendectomy. Incision and drainage of right thorax.	Died three months later.
8	Peritonitis one and one-half months before; pain in abdomen.	Discharging abdominal sinus.	Laparotomy, with drainage.	Died one year later.
9	Acute appendicitis one month before; abdominal pain.	Abdominal sinuses; mass in pelvis.	Appendectomy; drainage of pelvic abscess.	
10	Pain in abdomen and back; pelvic inflammation two years before.	Abdominal sinus and tumor; subcutaneous abscess.	Appendectomy; bilateral salpingectomy; incision of abscess.	Died six months later.
11	Pain in abdomen; "acute appendicitis" after "herniotomy" fourteen months before.	Discharging abdominal sinuses.	Herniotomy; appendectomy; dissection of sinus.	
12	Cough, pain in abdomen; irritable bladder.	Mass in abdomen; multiple sinuses.	Appendectomy; exploration for pelvic abscess five months later.	
13	Abdominal pain; fever and cough.	Multiple abdominal sinuses.	Appendectomy; drainage of subdiaphragmatic abscess thirteen months later, abdominal abscess two months later.	Died one year and five months later.
14	Acute appendicitis.	Abscess in abdomen; multiple sinuses; empyema following tonsillectomy.	Appendectomy; drainage of sinuses; tonsillectomy; drainage of thoracic sinuses.	Died one year later.
15	Acute appendicitis.	Multiple sinuses in abdomen and lumbosacral region.	Appendectomy and four subsequent operations.	Died one and one-half years later.

Died seven months later.

Died seven months later.

	Acute appendicitis.	Multiple sinuses in lumbosacral region.	Multiple sinuses in abdomen and pleurisy.	Drainage of thorax; treated as tuberculous.	Died one and one-half years later.
16	Intrathoracic pain. Pulmonary hemorrhage.		Multiple thoracic sinuses.	Drainage of thorax; treated as tuberculous.	Died seven months later.
17	Pain in thorax and fever. "Empyema."		Multiple thoracic sinuses.	Exploration and drainage.	
18	Lump in breast; ulceration anterior and posterior thorax. "Influenza."		Sinuses of left side of thorax.		Died seven months later.
19	Recurring attacks of abdominal pain (appendicitis) in June, 1920; flexure of thigh in December, 1920; psoas abscess in February, 1921. Great weakness.		Abdominal mass and sinus.	Appendectomy in October, 1920.	Died one year and three months later.
20	Abdominal pain; acute appendicitis.		Abdominal sinuses. Flexure of right thigh.	Incision, appendectomy and drainage.	Died three months later.
21	Abdominal pain in June, 1923; sub-diaphragmatic abscess one week later. Well six months, then pelvic abscess.		Mass in abdomen.	Exploratory laparotomy. Drainage.	Died two years later.
22	Pain in right hypochondriac region. Stiffness of right hip. Fever; weakness.		Mass in right renal region. General condition poor.	Incision and drainage of mass in upper right side of abdomen. Treated for typhoid fever.	
23	Abdominal pain; pain around right thigh; pleurisy.		Tender abdominal mass.	Appendectomy.	Died one and one-half years later.
24	"Influenzal pneumonia" in 1919.		Discharging sinuses in thorax.	Thoracotomy in 1920; later incision of abscesses. Treated as influenzal pneumonia.	Died five months later.
25	Abdominal pain and diarrhea.		Tender abdominal mass.	Incision and drainage for appendiceal abscess.	Died four months later.
26	Sudden pain in the right side of thorax followed by axillary abscess.		Discharging sinuses in right posterior thorax; bronchial fistula.	Thoracotomy and drainage.	Died one year later.
27	Appendicitis.		Discharging abdominal sinuses.	Appendectomy; drainage of abscesses.	
28	Abdominal pain; appendicitis.		Mass in abdomen.	Appendectomy; drainage of abscesses.	
29	Abdominal pain; acute appendicitis.		Abdominal mass and sinuses.	Appendectomy; drainage of abscesses. Heliotherapy.	Died one year later.
30	Abdominal pain.		Discharging abdominal sinuses and mass in right groin.	Appendectomy; drainage of sinuses.	

TABLE II
TREATMENT AFTER DIAGNOSIS OF ACTINOMYCOSIS AND SUBSEQUENT COURSE OF THE DISEASE

Case	Surgical and medical	Treatment		Results	Remarks
		Radium, mg. hours	Röntgen rays, courses		
1	Potassium iodide and sodium iodide.	205 to vagina	2 whole abdomen	Marked improvement.	See <i>Annals of Surgery</i> , Jan., 1925, p. 348.
2	Exploration and drainage of sinus; potassium iodide.	450 in wound	1 over sternum	Improved and lived about a year.	Further X-ray treatment at home. Dead.
3	Potassium iodide.	2,044 in sinus; 8,586 to abdomen	2 abdomen	Improved markedly.	
4	Potassium iodide.		1 abdomen	Improved; then recurred four and a half years later.	Dead.
5	Drainage of abscess in abdomen; potassium iodide.		1 abdomen	Steady deterioration.	Dead.
6	Drainage of abscess; potassium iodide.		2 abdomen	Steady deterioration.	Poor condition on arrival. Dead.
7	Exploration of sinus; potassium iodide.		2 abdomen	Brief improvement.	Poor condition on arrival. Dead.
8	Potassium iodide.	12,000 to right lower quadrant	1	Brief improvement.	Potassium iodide at home for one year. Dead.
9	Exploration and dissection of sinus; potassium iodide.	200 in sinus; 1,400 to inguinal region	3	Convalescence slow.	Well over two years later.
10	Potassium iodide.		1	Not heard from.	
11	Drainage of sinus; potassium iodide.	21,068 to anterior abdomen	3	Improved steadily.	Well December, 1925, two and a half years later. Still living.
12	Drainage of subdiaphragmatic abscess, then of sinuses; potassium iodide.		1	No interval notes.	Died seventeen months later.

13			1	Improved steadily.	One course X-ray treatment at home. Dead.
14	Sodium iodide.		2	Brief improvement.	Dead.
15	Curettement of sinuses; rib resection.		1	Improved.	Died seven months later.
16	Rib resection; potassium iodide and sodium iodide.		2	Improved.	Living.
17			4	Steady improvement.	Well for one year.
18	Curettement of sinus; potassium iodide.	500 to sinus	3	Improved temporarily.	Dead.
19	Exploration of sinus; potassium iodide.		1	Improved.	Died three years later.
20			1 at high voltage	Steady deterioration.	Dead.
21	Exploration of sinus; potassium iodide.		1	Not heard from.	
22	Drainage of psoas abscess; potassium iodide.		1	X-ray treatment incomplete.	Lived one and a half years.
23	Drainage of abscess in chest.		1	Improved briefly.	Dead.
24	Exploration and drainage.		1	Steady deterioration.	Dead.
25	Drainage; potassium iodide.		1	Steady deterioration.	Dead.
26	Potassium iodide.		1	Improved.	Well one year later. Still living.
27	Drainage; potassium iodide.		1	Improved.	Well two years later. Still living.
28	Potassium iodide.		3	Temporary improvement.	Dead.
29	Drainage; potassium iodide.	4,100 to sinus	1	Improved.	Well one and a half years later. Still living.

erythrocytes numbered 3,660,000 and leukocytes 13,000. The urine was essentially normal. Smears of pus from the draining abdominal wounds showed *Actinomyces*.

The patient's temperature varied between 98.2 and 101° F. for nine days, and then fell to the normal level. A first course of roentgen irradiation of the abdomen, through four anterior and four posterior fields, was given between March 31 and April 6, 1926. The patient began to improve at once. When he returned May 13 for the second course of treatment he was much improved, and the course was taken in four days. July 26, he came for the third course of treatment. He had gained 29 pounds in weight, felt entirely well, and was a picture of health. The third course of irradiation was given between July 26 and 29. The patient has remained well.

Further surgical procedures were not undertaken after the character of the disease was established by the finding of *Actinomyces*, but the patient received increasing daily doses of potassium iodide besides the roentgen-ray treatment. This may have helped to effect a cure, but the chief factor in the result must have been irradiation of the abdomen.

CONCLUSIONS

Many cases have been reported to show that roentgen rays are a potent therapeutic agent against *Actinomyces* in lesions of actinomycosis.

The earlier and the more superficial the lesions the more rapidly they are made to involute and disappear by exposure to roentgen rays.

Actinomycotic lesions around the head and neck can nearly always be eradicated by thorough irradiation, by drainage of purulent collections, and by the internal use of increasing daily doses of sodium or potassium iodide; irradiation is undoubtedly the chief factor in the cure.

When actinomycosis attacks the intestine or the lungs, the disease often becomes extensive before its true character is recognized. Irradiation in such cases is seldom successful in effecting a cure, but slight or great improvement is not uncommon. Better results could undoubtedly be obtained if the diagnosis were made and the treatment instituted earlier.

BIBLIOGRAPHY

1. ASKANAZY, M.: See Aschoff, Ludwig: Pathologische Anatomie. G. Fischer, Jena, 1923, 805 pp.
2. VON BERGEN: Einige Fälle von Aktinomykose geheilt mit Radium. Zentralbl. f. Chir., 1916, XLIII, 849.
3. BEVAN, A. D.: Actinomycosis. Ann. Surg., 1905, XLI, 641-654.
4. BRUNZEL, H. F.: Kasuistischer Beitrag zur Behandlung der Aktinomykose mit Röntgenstrahlen. Strahlentherapie, 1915, VI, 253-256.
5. HARRIS, F. G.: Actinomycosis of the Neck. Jour. Cutan. Dis., 1916, XXXIV, 616.
6. HARSHA, W. M.: Actinomycosis of Jaw. Ann. Surg., 1904, XXXIX, 459-460.
7. HEYENDAHL, P. A.: Einige Fälle von Aktinomykose geheilt mit Radium. Zentralbl. f. Chir., 1916, XLIII, 849.
8. ISELIN, HANS: Von der Behandlung der Knochen- und Gelenktuberkulose mit Röntgenlicht. Deutsch. Ztschr. f. Chir., 1910, CIII, 483-515.
9. JENSEN, V. W., and SCHERY, C. W.: Actinomycosis Treated with Methylene Blue and Roentgen Ray. Jour. Am. Med. Assn., 1920, LXXV, 1470-1472.
10. KAARSBERG, J.: Einige Fälle von Aktinomykose geheilt mit Radium. Zentralbl. f. Chir., 1916, XLIII, 849.
11. KAPLAN, I. I.: Ein seltener Fall von Aktinomykose—Appendicitis. Arch. f. klin. Chir., 1924, CXXVIII, 410-416.
12. LEVY, R.: Röntgenbestrahlung der Aktinomykose. Zentralbl. f. Chir., 1913, XL, 121-122.
13. MATTSO, W. W.: Human Actinomycosis, with Special Reference to Source and Mode of Infection. Surg., Gynec. and Obst., 1922, XXXIV, 482-494.
14. MELCHIOR, EDUARD: Klinische Erfahrungen über kombinierte Jod-Röntgentherapie der cervico-facialen Aktinomykose. Berl. klin. Wchnschr., 1916, LIII, 586-588.
15. NEW, G. B., and FIGI, F. A.: Actinomycosis of the Head and Neck: a Report of 107 Cases.

- Surg., Gynec. and Obst., 1923, XXXVII, 617-625; Radium, 1924, II, 257-271.
16. PONFICK, E.: Die Aktinomykose des Menschen, eine neue Infektionskrankheit auf vergleichend-pathologischer und experimenteller Grundlage geschildert. Berlin, 1882.
 17. PORDES: Nach drei Röntgenbestrahlungen geheilter Fall von histologisch sichergestellter Aktinomykose aus dem Institut Holzkecht. Wien. klin. Wchnschr., 1916, XXIX, 724-725.
 18. PUSEY, W. A.: A Case of Actinomycosis or Sarcoma Treated with Roentgen Rays. In "The Roentgen Rays in Therapeutics and Diagnosis," by W. A. Pusey, and E. W. Caldwell. W. B. Saunders and Company, Philadelphia, 1904, 690 pp.
 19. ROVSING, T.: Einige Fälle von Aktinomykose geheilt mit Radium. Zentralbl. f. Chir., 1916, XLIII, 849.
 20. SARDEMANN, EMIL: Ueber die Behandlung der Aktinomykose mit Röntgenstrahlen. Beitr. z. klin. Chir., 1914, XC, 157-167.
 21. STEINKE: Actinomycosis Cured by the Roentgen Ray. Jour. Cutan. Dis., 1918, XXXVI, 187-188.
 22. WICKHOFF, M.: Demonstration eines Falles von Röntgentherapie bei Aktinomykose; Heilung. Wien. klin. Wchnschr., 1917, XXX, 26.
 23. ZEISLER, JOSEPH: Notes on a Case of Actinomycosis. Jour. Cutan. Dis., 1906, XXIV, 510-512.

DISCUSSION

DR. R. H. STEVENS (Detroit): I was much interested in the paper on actinomycosis. I did not know there were so many cases of it in the world as there have been at the Mayo Clinic. Our experience with the disease in Michigan has not been great, but in the one or two cases I have treated I have given iodine in combination with the X-ray, having a theory that the iodine sensitizes the fungus to the X-ray. With one of these cases, treated some little time with X-ray, I did not seem to be getting results. Then by pushing the iodine and giving the X-ray treatment along with it, the case entirely cleared up. It was one of extensive involvement of the jaw and soft tissues about the face, of some time standing.

DR. L. R. SANTE (St. Louis): There is one point in Dr. Desjardins' paper of which I would like to speak. It is unfortunate that

in all of these cases of actinomycosis that are reported, one cannot get the internist to let him treat it alone without the aid of potassium iodide. The case mentioned as having been reported by Dr. Schery was treated by me at the City Hospital in St. Louis nine years ago and from this case we can probably get an idea of the action of radiation without the use of extraneous treatment as nearly as we will ever be able to approach it. This patient, a woman, had a distinctive and typical lesion on the jaw, involving the entire side of the cheek. The organism was found and verified by several pathologists. The only potassium iodide the patient received was five grains three times a day for three days, two weeks before any X-ray treatment was started. There was no particular evidence of any influence on the lesion with this amount. Local applications of copper sulphate were then started and tried for a few days, but the lesion spread like wildfire, and there were quite edematous lesions of both eyelids. About a week later we were permitted to treat it with X-ray. To determine whether or not it would have any effect, half of the lesion was covered with a sixteenth of an inch of lead, and only the lower half was treated. Almost at once—within twenty-four hours—one could see the effect, and within three days it was so pronounced in the part treated and the extension so evident in the part untreated that we did not dare wait any longer to give the remaining portion a full dose of radiation. All the patient ever received was one erythema dose, 9 inch gap, 6 mm. Al., 5 ma., 16 inch distance, 40 min. exposure. The case went on to complete recovery and the woman has been well ever since.

DR. R. H. CROCKETT (San Antonio): I would like to ask Dr. Desjardins just what percentage of an erythema dose he gives in the treatment of actinomycosis.

DR. DESJARDINS: (closing): In connection with Dr. Martin's remarks on telangiectasis, it makes little difference whether filtered or unfiltered radiation is used; the chief question is the total dose given. Therefore, telangiectasis may be produced or avoided at will, and this depends largely on the ability of the radiologist to estimate the sensitiveness of a particular skin. It is true that more care must be used with unfiltered than with filtered radiation, because unfiltered radiation offers less latitude between the minimum and maximum of allowable erythema. This also involves the size of the area exposed. A small area of tissue, one inch or less in diameter, may be given two erythema doses without ensuing telangiectasis, but if a larger area is exposed to such a dose, telangiectasis will almost certainly occur later. Indeed, a very large dose may be given to a small area without injuring the blood vessels sufficiently to cause ulceration, but a similar dose to a large area is very likely to cause such ulceration.

With reference to the massive or fractional dose, the only experience I have had has been in connection with epithelioma of

the eyelids. During the past two years practically all such cases seen at the Clinic have been treated with roentgen rays. Before that time a number of cases had been treated with surgical diathermy, but it was difficult to be certain of destroying every part of the lesion in this manner without some unnecessary destruction of the surrounding normal tissue. Several of these cases recurred, and this induced us to try roentgen rays instead. In administering roentgen-ray treatment the lesion was carefully examined so as to determine as closely as possible the full extent of the associated infiltration. The entire zone, with a narrow margin beyond it, was carefully blocked out by means of heavy lead, and from two to three erythema doses of rays filtered through 6 mm. of aluminium and, immediately afterward, at the same session, three erythema doses of unfiltered rays were given. Cases treated in this manner have improved very rapidly and not one of them has recurred. The regression of lesions thus treated is so rapid that one can often see the change from day to day.

FUSO-SPIROCHETAL PULMONARY GANGRENE¹

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PULMONARY complications following surgery can be discovered quickly, their extent noted, and the differential diagnosis made with fair accuracy, wherever roentgen-ray facilities are available. Our accuracy of differential diagnosis has steadily but surely increased year by year until at the present time roentgen examination of the chest is quickly sought upon the first indication of post-operative pulmonary pathology. The list of pathologic conditions of the chest differentiated by the roentgen ray has been gradually enlarged during and following the late war. Possibly the most recent syndrome described and now uniformly recognized is that of massive atelectasis of the lungs.

The condition which we shall now consider is not a newly described one, but, nevertheless, is infrequently diagnosed. That it is more common than is generally supposed will be apparent on study of the accumulated literature.

Fuso-spirochetal pulmonary gangrene has become, during the past few years, a well recognized clinical picture, with frequent excellent clinical and pathologic descriptions appearing in the literature. A search through the *roentgenologic* literature, however, reveals that a noticeable lack of attention has been paid to this condition. Roentgenologic text-books also make little or no mention of the existence of such lesions.

LITERATURE

The first mention in the literature of this condition was by Castellani (1), in 1906, who described cases of hemorrhagic bronchitis caused by spirochetes. To this condi-

tion he gave the name of "bronchial spirochetosis." Kline and Blankenhorn (2) report four cases of spirochetal pulmonary gangrene. They believe that the organisms usually originate in an unclean mouth and that these spirochetes are not specific for the lungs. Nolf (3) reports nine cases of what he terms "fetid spirillar bronchitis," all in Belgian soldiers. He believes that these spirilla are entirely different from the spirilla usually found in the mouth. Pilot, Davis, and Shapiro (4) show that fusiform bacilli and spirochetes are often a complicating factor in pulmonary tuberculosis, and are usually responsible for the fetid expectoration in bronchiectasis and gangrene. The X-ray findings of fuso-spirochetal infections of the lungs have been described by Pilot (5). He describes the various lesions found in the lungs, together with their clinical course, and recommends salvarsan as the method of treatment.

Bacterial studies of the sputum reveal fusiform bacilli, spirochetes, and other bacteria, especially streptococci. Postmortem examination reveals an abundance of fusiform bacilli and streptococci, and a few spirochetes in the smears. Sections of the surrounding tissues, including the abscess wall, usually reveal large numbers of spirochetes. Kline (6) has shown experimentally that spirochetal gangrene can be produced in devitalized tissue with ease, while in normal tissue it is very difficult to produce, this strongly suggesting that a previously devitalized tissue is essential for its production. Maes (7) also makes the statement that dead tissue seems essential to the growth of this spirochete and the fusiform bacillus, which leads him to believe that these organisms are saprophytic in character. Smith and Rusk (8) also conclude that there is

¹Read before the Radiological Society of North America, at the Thirteenth Annual Meeting, at New Orleans, Dec. 1, 1927.

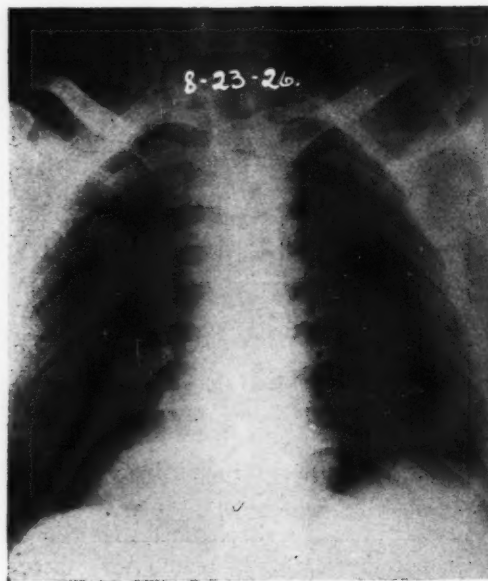


Fig. 1. Case 1. Lung abscess six days following hernia operation. At this time small consolidation only is seen.

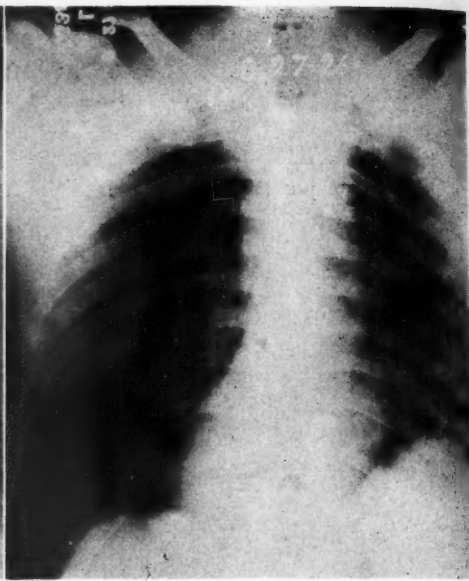


Fig. 2. Case 1. Fusio-spirochetal pulmonary gangrene ten days after hernia operation. Bronchopneumonia in right base. This film shows rapid increase of cavitation.

some primary destructive lesion followed by secondary invasion by these organisms.

CLINICAL FINDINGS

In those cases where the disease is primary the onset may be rather sudden, with an initial chill. This is followed by general malaise and pain in the chest, with cough. The temperature is elevated and usually irregular. The general condition gradually becomes worse, with loss of strength and the development of cyanosis. The sputum gradually becomes more abundant. It is purulent, of a greenish yellow color, and is always fetid.

In the aspiration cases the onset is usually from three to six days following infection and the foul expectoration comes on in from twelve to fourteen days.

On physical examination these cases commonly give the signs of a gradually developing bronchitis, but frequently the findings

are indefinite. Bronchopneumonia is found in certain cases. Gangrene may be either diffuse or in scattered foci, and goes on to the development of abscess cavities.

ROENTGEN-RAY FINDINGS

These vary somewhat according to the location of the lesion and the ease with which the pulmonary resistance is overcome. In some cases one sees the roentgen changes ordinarily seen in aspiration pulmonary abscess, except that these abscesses are likely to be not so circumscribed in appearance. They excavate rapidly, with the production of large amounts of extremely foul-smelling sputum. The inner wall of this abscess cavity may be rather dense and thick but around this will be seen a hazy shadow representing infiltration extending into the surrounding lung tissue. We have observed one of these lesions progress in a period of ten days from a small area of consolidation

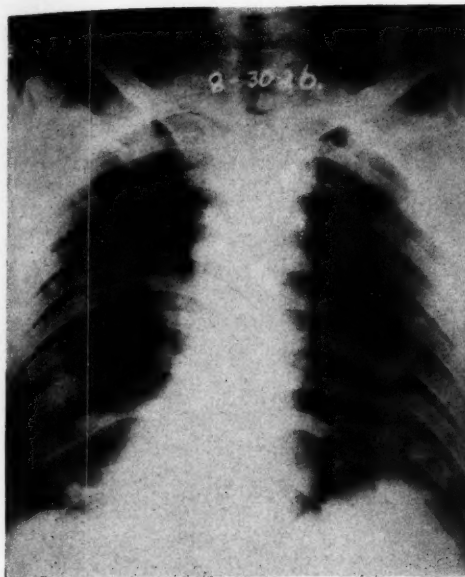


Fig. 3. Case 1. The condition thirteen days after hernia operation. Marked extension of the gangrene and cavitation. Bronchopneumonia in right base.

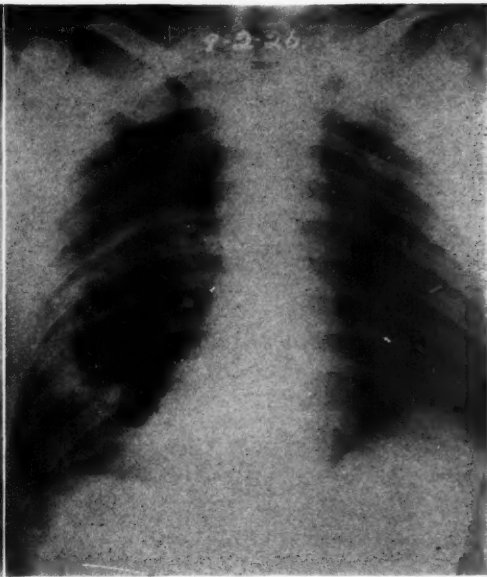


Fig. 4. Case 1. The condition sixteen days after hernia operation. Continued enlargement of the abscess cavity. Death of the patient ensued three days after this film was taken.

to complete excavation of the lower lobe of the lung. As softening occurs and emptying follows, the usual air-containing cavity will be seen. Such a cavity frequently contains fluid, and, if of sufficient size, a fluid level will be present.

In those cases presenting the findings of gangrene the shadows are much more diffuse, suggesting areas of pneumonia. When these lesions break down they are likely to cavitate in several places at the same time. These may then coalesce, with involvement of a large portion of the lung.

When this infection complicates an already existing bronchiectasis, the pre-existing shadows become more diffuse, gradually spreading over the base of the lung and causing a more or less uniform involvement. These also break down, with the formation of multiple cavities and the expectoration of a foul-smelling sputum. Occasionally these cavities rupture into the pleural cavity, with the formation of an exudate which may become purulent.

CASE REPORTS

Case 1, No. 80,539, M. S., white male, age 49. The patient was admitted complaining of a bilateral inguinal hernia, which was confirmed by physical examination. The examination was otherwise negative with the exception of rather marked pyorrhea and tonsillitis.

The operation was uneventful and there was very little post-operative nausea. The following day there was some fever, slightly below 100° . Several days following this the temperature began to rise gradually. Physical examination of the chest, however, was negative. X-ray examination of the chest on the sixth day showed a small area of consolidation suggesting lung abscess. Sputum on this day showed no spirochetes or fusiform bacilli. These were constantly found in the sputum after this date. This followed rupture of the abscess into a bronchus. Salvarsan therapy was begun on the fifteenth day.

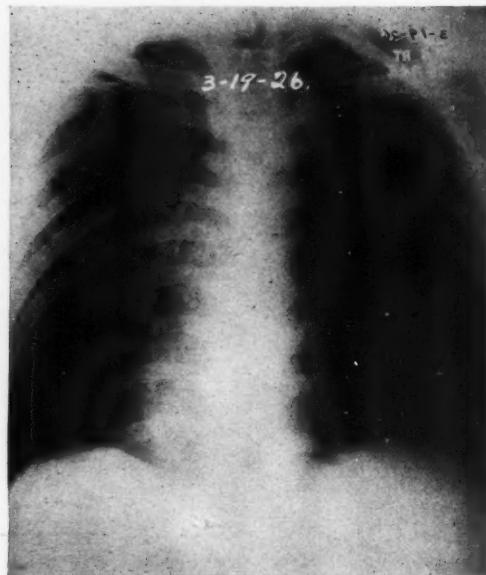


Fig. 5. Case 2. Fusso-spirochetal pulmonary gangrene nine days after a chill, with fever, and pain in the chest.

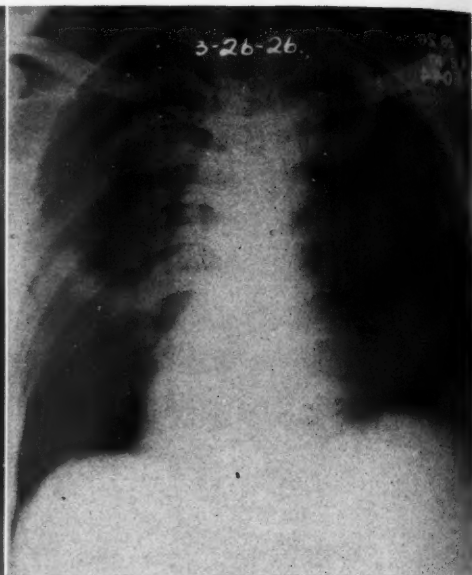


Fig. 6. Case 2. Fusso-spirochetal pulmonary gangrene sixteen days after onset. Marked progression of the lesion, with extensive cavitation.

The abscess cavity extended in size much more rapidly from day to day than is the case in the ordinary lung abscess. During this time a bronchopneumonia also developed in the right base, which gradually cleared up.

The patient continued to grow weaker, and death ensued on the nineteenth day.

Postmortem examination.—This revealed marked pyorrhea alveolaris from which were cultivated spirilla and fusiform bacilli. The base of the left lung was gangrenous and contained a large cavity. Smears from the fluid in the lung cavity showed spirilla and fusiform bacilli, together with many other organisms. There was also a small area of bronchopneumonia in the right base. The other findings in this examination were not significant.

Case 2, No. 75,004, S. S., white male, age 34. The patient entered the hospital complaining of pain in the chest and giving the history that two weeks previously he had

had a cold, and nine days previously had experienced a chill followed by fever and pain in the chest.

Physical examination of the chest at this time revealed a probable bronchopneumonia. Chest films the following day revealed an area of bronchopneumonia involving the central portion of the left lung. Two days following this a cavity was noticed in the center of the consolidation, suggesting the development of a lung abscess at this point. This was followed by films every few days, upon which was observed the very rapid development of the abscess cavity.

Ten days following admission spirochetes and fusiform bacilli were demonstrated in the sputum, which was very abundant. These were demonstrated several times following the first examination. Air was introduced into the chest to produce artificial pneumothorax. The lung, however, was prevented from entirely collapsing by a band of adhesions to the chest wall. About this

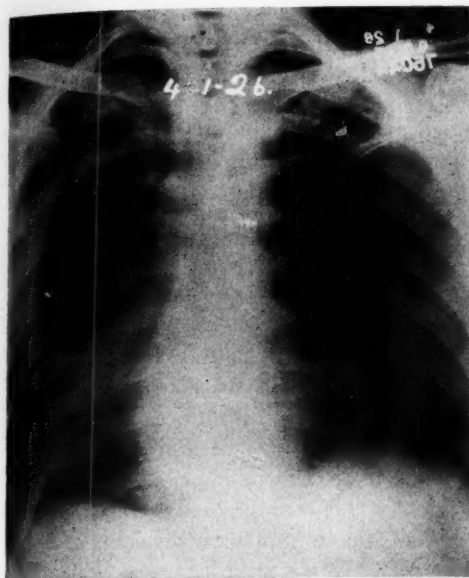


Fig. 7. Case 2. This film was taken six days later than Figure 6. Artificial pneumothorax, with adhesions to diaphragm.

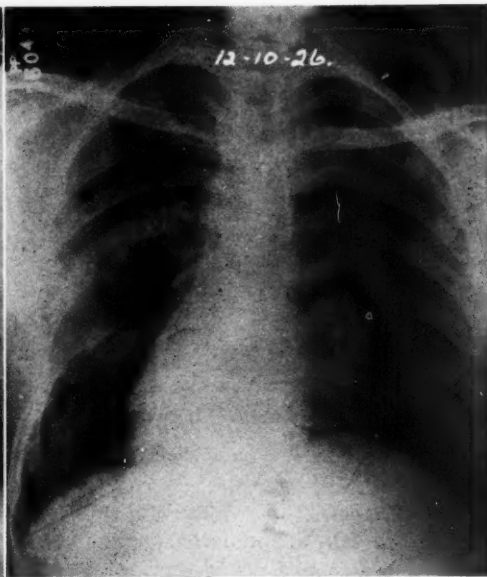


Fig. 8. Case 2. Film taken eight months later than Figure 7. Patient clinically well. Abscess cavity has been cauterized surgically.

time intravenous salvarsan injection was begun.

It was finally decided to cauterize the abscess cavity. On opening this it was found to contain about 100 c.c. of pus and necrotic tissue. The wall was thick, fibrous, and inelastic. The cavity was thoroughly cauterized and packed. This treatment was followed by gradual healing and shrinking of the abscess cavity, and the patient left the hospital about one month later.

Six months later the left lung was completely expanded. The abscess cavity showed complete healing, with some pleural thickening over this area.

SUMMARY

1. Post-operative pulmonary complications should suggest roentgen examination in the early stages.
2. Fusiform bacilli and spirochetes are the infective agents in this condition. Some

authors believe previously devitalized tissue is necessary for their growth.

3. Clinically this simulates a bronchitis or bronchopneumonia, except that the sputum is always fetid.

4. Roentgenologically this resembles lung abscess or pulmonary gangrene, except that the lesion is likely to progress much more rapidly than is the case in the ordinary type of infection.

5. The accepted treatment for this condition is salvarsan in the earlier stages and operation in the later chronic stages.

BIBLIOGRAPHY

1. CASTELLANI, A. Note on a Peculiar Form of Hemoptysis with Presence of Numerous Spirochetæ in the Expectoration. *Lancet*, 1906, I, 1384.
2. KLINE, B. S., and BLANKENHORN, M. A.: Spirochetal Pulmonary Gangrene. *Jour. Am. Med. Assn.*, Sept. 1, 1923, LXXXI, 719.
3. NOLF, P.: Fetid Spirillar Bronchitis and Pulmonary Gangrene. *Archiv. Int. Med.*, April, 1920, XXV, 429-448.
4. PILOT, I., DAVIS, D. J., and SHAPIRO, I. J.: Studies on Fusiform Bacilli and Spirochetes:

- VI. Their Association with Pulmonary Tuberculosis in Cavities, Bronchiectasis, and Gangrene. *Am. Rev. Tuberc.*, November, 1923, VIII, 249-259.
5. PILOT, I.: X-ray Studies of Fuso-spirochetal Infections of Lungs. *RADIOLOGY*, June, 1924, II, 424-429.
 6. KLINE, B. S.: Experimental Gangrene. *Jour. Infec. Dis.*, June, 1923, XXXII, 481.
 7. MAES, URBAN: Spirochetal Pulmonary Gangrene. *Internat. Clinics*, 1926, II, 197.
 8. SMITH, C. E., and RUSK, G. Y.: Pulmonary Spirochetosis. *Am. Jour. Pathology*, May, 1927, III, 225-234.

DISCUSSION

DR. W. F. HENDERSON (New Orleans): It is greatly to be regretted that the excellent paper which Dr. Doub presented was not heard by a much larger number of our group. Scarcely do we learn the behavior and peculiarities of a disease before our attention is drawn to another equally as fascinating, and this seems to be particularly true in the subject under discussion. It seems to me that attention has not been directed toward fuso-spirochetal pulmonary gangrene as much as the seriousness of the condition would warrant, for that it is a fairly prevalent condition is apparent. In this southern territory, we are seeing an increasingly large number of cases, as is illustrated by the fact that one observer who, one year ago reported 16 cases, now has a total of 54.

It seems scarcely necessary to mention the fact that the mouth should be thoroughly cleansed before the pathologist collects the specimen for examination. This procedure, however, is vital, since most mouths contain the organism of this condition in fairly large quantities, or organisms of a similar nature. Here in the South where the negro race is so numerous, it is not at all unusual to find that wounds which have been inflicted by a negro's teeth have become infected with organisms either closely resembling or identical with those of fuso-spirochetal pulmonary gangrene.

The organism of the condition now under discussion presents several morphologic as well as several cultural characteristics, and it

is not always possible to determine accurately by microscopic methods alone the exact strain of spirillum. It is even possible to transplant the organisms from suspected material into the peritoneal cavity of rabbits under certain circumstances.

The spirilla resemble very much those of lues, but with the important difference that lues produces a proliferation in the cells with a coagulation and is thus productive of gumma, whereas the organism of spirochetal gangrene elaborates a proteolytic enzyme. Of this enzyme it may be said that its action is extraordinarily rapid and the lysis occurs with such rapidity as to be dramatic. Patients who have hitherto been apparently well are stricken as by a plague, and within twenty-four to thirty-six hours their condition may become desperate. The cavities produced advance with such a dizzy speed as to render scarcely credible the evidence of one's own eyes.

In the early literature dealing with this subject, most of the lesions are described as being of from one to three centimeters in size, and it is true that we do see such in chronic cases. The acute conditions, however, progress to a total destruction of the lung in from ten to fifteen days, untreated. It is likewise true that in the past, cases with rapid destruction have come to a fatal termination before an adequate diagnosis has been reached, and that it is the more protracted or chronic case which has remained with us long enough to receive an adequate diagnosis.

The treatment is in many cases disappointing. Given the rapidly destructive type with acute onset, salvarsan appears to be a specific, provided the associated pathology can be cared for; but with the more chronic cases, it becomes necessary to repeat the salvarsan at intervals of three or four months over a period of years. Two patients who have been under my observation, with cavities approximately 4 cm. in diameter, have

been on this regimen constantly, a period of three months' rest practically always being followed by a retrogression and the re-appearance of the spirilla in the sputum. Such a recurrence, or the occurrence of a fulminating case in the presence of a previously

existing pathology, suggests the necessity for necrotic tissue as a basis for invasion, and I am inclined to think that we shall ultimately demonstrate that this organism is a secondary rather than a primary invader.

Experimental Investigations Regarding the Injury of the Offspring by Roentgen Rays. P. Schugt. *Strahlentherapie*, 1928, XXVIII, 546.

The effect of graded doses of roentgen rays of various wave lengths on the structure and function of the ovary was studied on white mice. The mice were obtained from different places in order to avoid inbreeding. The whole body of 60 animals was exposed to 140, 70, 54, 42, 27, 21, 14, and 9 R, of a radiation produced at 180 K.V., 2 ma., filtered through 0.5 Cu. plus 3.0 Al. Fifty-three animals were exposed to the same doses of a radiation produced at 100 K.V., 2 ma., and filtered through 1.0 Al. Ten days following exposure the females were paired with normal untreated males for from four to six weeks and then separated. For the six following weeks, the estrual cycle was studied. Some animals were killed at that time, while twenty-six, exposed to 54, 70, and 140 R, were paired again with

normal males for four months. The estrual cycle was studied for six weeks and the animals killed.

From the microscopical studies of the ovaries, it was concluded that a dose of 54 to 42 R corresponds to the castration dose of the mouse.

The offspring were carefully examined and weighed; 110 normals served as controls. Beginning in the eighth week, the first generation of the treated animals was paired within the group for four weeks. If they remained sterile, they were paired with normal males and normal females, respectively. The same procedure was carried out with the following generation. All results are carefully tabulated and permit the conclusion that the injury due to the irradiation as described above consists of under-development of the offspring and of a definite drop in the fertility.

E. A. POHLE, M.D

THE AUTOGENOUS BONE GRAFT IN SPONDYLOLISTHESIS

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THE increasing use of the X-ray as a diagnostic aid is gradually eliminating fallacies, based on purely clinical impressions. A striking illustration of this is the marked change of point of view toward spondylolisthesis in recent years. Once con-

sidered comparatively rare, and attracting the interest of obstetricians rather than surgeons because its incidence was believed to be closely associated with pregnancy, the peculiar displacement is now frequently revealed by the X-ray in accident cases, and is



Fig. 1. A case of spondylolisthesis which was relieved by the inlay tibial graft after much conservative treatment had failed. Arrow 1 indicates congenital lack of development of lamina of fifth lumbar vertebra. Arrows 2 and 3 indicate tibial graft.

quite as common in men as in women. Twelve of the 19 cases which the author has seen were in men.

Spondylolisthesis is a displacement of the whole spinal column forward in relation either to the fifth lumbar vertebra and sacrum and pelvis, or the sacrum and pelvis. There is forward subluxation of the body of the fourth or fifth lumbar vertebra on the vertebra below it, or upon the sacrum. The fifth lumbar vertebra is most commonly displaced, the fourth less often, and the sacrum rarely. In a very large percentage of cases there is a contributing cause of congenital failure in vertebral development (Fig. 1).

Inasmuch as the symptoms are due to the vertebral displacement, resulting in overstretching and undue tension upon the ligaments surrounding the vertebrae (increased by standing and lifting), the *rationale* of treatment is almost entirely mechanical. Little can be accomplished by the application of braceage or plaster jackets, in that the only counter-pressure that could possibly be effectual must come anteriorly, in order to exert its influence on the anterior surface of the vertebral bodies displaced. Obviously, pressure through the abdominal cavity cannot be sufficiently immobilizing to be effectual, and this accounts for the fact that no cure by braceage treatment is reported in the literature.

The mechanical features of the autogenous bone graft operation are exceptionally well adapted to this most difficult problem. A strong autogenous graft inlaid into the spinous processes of the lower lumbar vertebrae and carefully coapted onto the posterior surface of the sacrum affords very firm immobilization (Figs. 1 and 3). Operative procedures which do not include a strong graft are not trustworthy (See Fig. 2).

Without exception, the results have been most satisfactory in the eleven cases in



Fig. 2. Case 18 months after an unsuccessful attempt at fusion for spondylolisthesis. Symptoms naturally were unaffected. The same case is shown in Figure 3, after insertion of tibial graft, followed by complete relief of all symptoms.

which the author has employed this operation.

TECHNIC

The tips of the spinous processes of the lower lumbar vertebrae and posterior part of the sacrum are laid bare by an incision curving slightly to the right side. Exposure is afforded by turning up a flap consisting of skin and soft parts down to the superficial fascia. The soft parts are not separated from the spinous processes of both the lumbar vertebrae and sacrum, as they are split *en masse* with spinous processes.

The supraspinous and intraspinal ligaments are split by the scalpel, passing over the central portion of the tip of the spinous processes and in between them. The small spinous processes on the posterior surface of the sacrum are likewise located, and the ligamentous structures split over their tips and in between. With a sharp broad Albee osteotome, the spinous processes of the lumbar

vertebrae are split longitudinally as near their centers as possible, care being taken not to fracture the halves of the spinous processes opposite the operator (the operator standing on the left side of the patient). The portion of the spinous process toward the operator is forced laterally toward him and may be in more than one fragment, but, as these fragments are embedded in the firm supraspinous ligament, no disadvantage is entailed. The small spinous processes of

the upper two segments of the sacrum are treated likewise, and their left halves displaced laterally with the embedding ligaments sufficiently to allow a graft of the full thickness of the tibial cortex to be inserted between them.

After splitting the spinous processes, shavings and particles of bone are turned toward each other and the sacrum from the inferior surface of the next spinous process above it. This is done to add additional



Fig. 3. Same case as that shown in Figure 2, after a strong tibial graft has been inserted into the posterior surface of sacrum and the spinous processes of the third, fourth, and fifth lumbar vertebrae. The result is excellent, with complete relief of symptoms.

osteogenetic material and influence to the graft later to be inserted.

With an osteotome and curette the posterior area of the sacrum, with which the graft is to be coapted, is thoroughly scarified.

By means of a lead bar or a flexible probe, the entire contour of the proposed graft is obtained. The contour of the graft is illustrated in Figures 1 and 3. Extreme care should be taken to get an accurate pattern of the posterior part of the sacrum and its angulation with the general axis of the lumbar column.

The spinal wound is then packed with a hot saline compress, and the anterior internal surface of the central portion of the left tibia is laid bare by an incision from the crest.

With the moulded probe as a pattern, the proposed graft is carefully mapped out on the anterior internal surface of the tibia by means of strokes of the scalpel in the periosteum. As it is desirable to have the sacral end of the graft stronger, this will be the inferior end, because the cortex in the lower end of the tibia is thicker than in the upper.

As soon as the graft is removed, it is inserted into the bed already prepared for it in the lumbar vertebræ and sacrum. It is firmly seated, particularly onto the sacrum, by means of the bone-set (the counterpart of the carpenter's nail-set) and mallet, at the same time that force is being exerted to overcome as much as possible of the spondylolisthetic displacement. The deformity is further corrected by the tension of the strong kangaroo tendon sutures which are used to grasp and immobilize the graft thoroughly in the firm ligamentous structures of the lumbar spine and sacrum.

The back and leg wounds are closed in the usual manner. Generous dressings of gauze and absorbent cotton are applied. These dressings should be particularly large over the spinal wound.

The patient is then placed in the dorsal position upon a fracture mattress, where he is kept for seven weeks. A low corset brace is then applied, with a surcingle around the lower end. This is worn for from four to six months. Figures 1 and 3 illustrate the end-results.

EDITORIAL

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A CONSIDERATION OF SOME CHANGES IN DIAGNOSTICS OF STOMACH DISEASES IN THE COURSE OF TWO DECADES¹

The application of the roentgen ray to the investigation of diseases of the abdominal organs has produced advances hardly equalled in any other field. This is the more remarkable in view of the fact that this method has been in use for a period of only slightly over two decades. The inadequacy of the former methods of investigation has been realized since the introduction of contrast media into the digestive tract has made the abdomen transparent, so to speak. A few examples will suffice to illustrate the radical change of our conceptions on diagnosis and treatment due largely to the newly developed roentgenologic signs.

Formerly the pylorus was regarded as the most common seat of peptic ulcer. Signs of pyloric obstruction, such as dilatation of the stomach, visible peristalsis, copious vomiting, and the finding of *Sarcinae* in the gastric contents were looked upon as the most cardinal symptoms of peptic ulcer. Only rarely could the diagnosis of ulcer of the corpus of the stomach or of the duodenum be made, since the signs were entirely insufficient. If there occurred intervals free from symptoms, the case was labeled as one

of gastric neurosis. Thus it came about that perforation and gastric hemorrhage were considered as important findings in arriving at a correct diagnosis. It is quite obvious that at this stage of the disease the outlook for successful treatment was rather poor.

To-day we regard perforation and severe gastric hemorrhage as complications that may occur, not as symptoms of the disease. If the frequency of these complications has diminished, this is largely due to the prevention of such occurrences by efficacious medical treatment and, even more, by proper and timely surgical intervention.

In looking over the statistics of peptic ulcer, we find that its location at the pylorus is rather infrequent. Duodenal ulcers are by far the most frequent—about three times as frequent as all other gastric ulcers together. The next in frequency is the gastric ulcer at the lesser curvature of the descending portion, and, finally, in equal proportions the prepyloric and the pyloric ulcer with a frequency of 5 per cent each. These proportions in frequency of the various locations of peptic ulcer are derived from data obtained by means of reliable X-ray signs. The periodicity in the clinical course of the ulcer, such as periods with definite symptoms alternating with intervals free from complaints, is regarded as being characteristic for the diagnosis, and some physicians even go so far as to value such a periodical course of the hypersecretion-type as in itself sufficient for the diagnosis of an ulcer.

Roentgenologic experience, however, contradicts this apparently simple method of diagnostics and demonstrates in which cases there is an ulcer present—I might say *al-*

¹Translation by Dr. David Reisner.

ready present—and in which cases no ulcer can be shown at the time of the examination. The experienced and critical roentgenologic observer is prepared to admit the existence of a neurotic disposition, as revealed by disturbances in the gastro-duodenal function, both in regard to the motor and the secretory factor. It seems to be of importance to emphasize this, particularly at a time when there is perhaps a leaning to diagnose peptic ulcer too often.

The recognition of carcinoma of the stomach has evidently encountered great difficulties. The operative statistics reported in the work of Clairmont and the writer, in 1911, on the importance for surgery of radiology of the stomach, show numerous exploratory, erroneous, and late laparotomies. Due to the uncertainty of clinical symptoms, quite frequently the nature of a palpable tumor mass in the region of the stomach could not be cleared up until the patient was on the operating table. In cases of gastric complaints, where a carcinoma was suspected, the tumor was searched for and frequently not found; in others, a carcinoma was found but proved to be inoperable. In such cases a gastro-enterostomy was carried out almost with regularity. Differentiation between a callous tumor on the basis of an ulcer, and a carcinoma was rather difficult, even when the abdomen had been opened up. In certain cases of apparently inoperable carcinoma, when the abdomen had been closed without removal of the tumor, the further course of the case gave evidence of an incorrect diagnosis; in others, resected carcinomas proved to be ulcers.

To-day the diagnosis of gastric carcinoma is put on a firm basis. Both the medullary and the scirrhus type can be recognized at an early stage. The contour of the mucous membrane of the stomach, the outline of the fully unfolded organ, the observation of its peristalsis and its motility gave us such

numerous and valuable points of information regarding the condition of the gastric walls that *the roentgenologic diagnosis of gastric carcinoma is made almost entirely independent from the clinical symptomatology and subjective complaints*. The positive diagnosis can be made with great reliability and the negative diagnosis with a high degree of probability, *i.e.*, a carcinoma may be excluded even in the presence of clinical signs suspicious of malignancy. The differentiation from ulcer is made by means of a series of morphological studies. This differential diagnosis is facilitated by the fact that carcinoma practically never occurs at the most common seat of ulcer, namely, at the superior portion of the duodenum. On the other hand, ulcer is relatively rare in the prepyloric region, which is the most common location for a carcinoma. Benign tumors and pathological processes leading to a circumscribed shrinkage, and in their appearance resembling a carcinoma, are rare occurrences in the stomach. Roentgenologic experience shows, on the other hand, that much too often the stomach is considered the starting point of those numerous symptoms and complaints referable to the epigastrium. These complaints are indefinite and may be regarded as a symptomatic neuralgia originating in the plexus solaris, which responds in the manner of a very sensitive alarm-apparatus to every irritation in the abdominal area.

We see, then, that *exploratory and erroneous laparotomies have become great rarities*, and the reliability of positive and negative X-ray findings in the stomach and duodenum has stood the test in innumerable autopsies. *The remarkable progress of gastric surgery is due to the development of roentgenologic study of diseases of the stomach, and shows the highest standards in those places where properly selected material is referred to the surgeon after exact roentgenologic examination.*

Resection is now the indicated procedure for a carcinoma. However, the late appearance of symptoms and in many cases their erroneous interpretation still handicap to a considerable extent an early diagnosis.

Gastro-enterostomy has stepped more into the background. The roentgenologic motility test has shown quite convincingly that the outlet of the stomach is very rarely obstructed to such a degree as not to permit the passage of semi-liquid food. This may be readily observed on the fluoroscopic screen after administration of the semi-liquid barium suspension.

In tumors located outside of the pylorus the passage is usually not interfered with, no matter how large the tumor or how extensive the infiltration may be. In these cases we observe an acceleration of gastric motility as a result of the persistently opened pylorus, due to achylia and the ab-

sence of the pyloric reflex. If there is an anatomical stenosis of the pylorus present, the lumen will be narrowed in consequence of the rigidity and stiffness of the wall; still, at the same time, it will be sufficiently wide to allow the passage of semi-liquid contents as a result of the incompetency. Occasionally the stomach may show an extensive infiltration down to the pylorus and the "passive" emptying will go on with increased rapidity.

It appears, therefore, that palliative surgical measures have a limited field of application. The radical method, however, which may preserve the patient's life after removal of the diseased part, has gained in importance as a result of improved diagnostic methods.

PROFESSOR DR. MARTIN HAUDEK,
*Director, Roentgen-Department,
Wilhelminen-Hospital, Vienna.*

LEARNING FROM THE MAKERS

There is no greater mistake that radiologists may make than to imagine that manufacturers of X-ray apparatus, radium chemical companies, makers of screens and cassettes, and chemists who compound dyes and contrast media speak only through their *sales departments*. The *research departments* have something to say, and the messages which they convey from time to time in the columns of RADIOLOGY are well worth study.

If a roentgenologist were forced to make his own Coolidge tube, his own fluoroscope, his own screens, compound his own gall-bladder dyes, he would learn something in the processes which might assist him toward a more understanding use of these modalities. But in this age of specialization groups of experts produce these commodities, and in the process make valuable discoveries and learn ways to adapt them in practice.

Since the educational and research departments of the manufacturing companies are broad-minded enough to realize that generalized information may be trusted to create uses, and that trade will naturally follow, professional men may well avail themselves of the suggestions put within their reach.

The editorial policy of this journal embraces the publication of technical papers by research workers when such contributions are scientifically sound and of demonstrable value, and so long as there is no inclination to abuse the privilege by implied exploitation of products or processes.

As a case in point, a paper on planning X-ray departments, both of hospital scope and for private installations, by the Director of the Engineering Service of the Victor X-ray Corporation, Mr. B. H. Arnold, and Mr. A. M. Obrieht recently appeared in this journal. We have in preparation a paper on fluorescent screens, emanating from the Re-

search Department of the Patterson Screen Company.

There exists a natural unity of purpose between him who devises apparatus and him who either actually uses it or prescribes its use. Radiologists can never alienate themselves from the makers of X-ray and radium instrumentalities, nor have they intention or desire to do so, as evidenced by the sustained interest in the exhibits.

THE RADIOLOGICAL "SPECIAL" TO THE CONGRESS

To Dr. B. H. Orndoff great credit is due for the happy culmination of an epochal journey participated in by 60-odd members of the Radiological Society of North America in attendance upon the Second International Congress of Radiology at Stockholm. There is only one note of regret, in that so few of our members availed themselves of the opportunity to combine, at such a modest cost, one of the most interesting and scenic journeys on earth with the most outstanding radiological congress the world has yet seen.

The tour began with ten happy and frolicsome days aboard the Norwegian-American liner *Stavangerfjord*, a steamship commanded by a true Viking, Captain Irgens, in which good food, good fun, and good fellowship predominated. Then over Norway's placid fjords, rugged mountains, and scenic valleys to the capital, Oslo, where we regretfully took leave of our Bennet tour representative, Mr. Ellingsen, who had been untiring in his efforts to make us comfortable. We took the night-train for Stockholm, arriving there early Sunday morning in time to rest and prepare for the strenuous week ahead. A large volume would not cover descriptively all that was worth recording, even with the omission of the entire scientific program. The writer will, therefore, merely attempt to give his per-

sonal impressions in the briefest manner possible.

THE SECOND INTERNATIONAL CONGRESS OF RADIOLOGY

The setting of this historic event will never be effaced from the memory of those who participated. No matter where and when future congresses may convene, the Stockholm Congress of 1928 will stand out as a splendid achievement, one that it will seem impossible for any other nation to surpass.

Official Opening.—This took place in the city's large Auditorium Building in the presence of approximately eleven hundred registered members and many guests. His Royal Highness The Crown Prince and several members of the Royal Family were present. The Crown Prince addressed the Congress in excellent English and paid high tribute to the science of radiology. President Forsell made welcoming addresses to the members in English, French, and German, after which he was presented with the badge and gold chain of office by the former president, Dr. C. Thurstan Holland, of England.

The Scientific Sessions.—These were held in the impressive Parliament Building, which had been secured by the local committee for the exclusive use of the Congress. This massive structure with its large audience chambers, its spacious halls and innumerable committee and guest rooms, was splendidly adapted for the purposes of the scientific sessions of the Congress. Each audience chamber was supplied with automatic timing devices which served admirably to expedite the program. Efficient secretaries made the section chairmen's work a pleasure and uniformed pages operated simultaneous announcement boards so that each member could see at a glance all the work as it progressed in the six audience chambers.

The demonstration of the work at Radi-

umhemmet deserves special mention. As the speaker read abstracts of each case record presented, lantern slides showed graphically the main points, including photographs before, during the progress of, and after the treatment. Each patient under discussion passed in turn under a spot light, and the demonstration was vividly and masterfully concluded.

The Commercial Exhibits.—These were housed in a building across the bay from the Parliament, and busy ferries provided by the local committee made frequent trips to and fro. One of the striking facts connected with the exhibit of X-ray apparatus was that only valve tube rectifiers and motorless transformers were in evidence. The writer failed to see a single rotary converter or rectifier in the place. A number of very handsome and business-like machines from various foreign countries were attractively displayed.

The Social Program.—This was by far the most elaborate that the writer has ever known of in connection with a medical congress. Space will not permit of more than brief mention of the major events. The local committee were hosts at a buffet supper and dance given on one of the first evenings at the famous Berns Saloner Restaurant, where over two thousand members and guests were royally served and entertained until into the small hours of the morning. The following night an invitational banquet to the members, given by the city officials of Stockholm, took place at the beautiful City Hall, an edifice which has perhaps no equal of its kind in the entire world. The banquet was served to the members and their ladies in the Golden Salon, a room the beauty and magnificence of which beggars description. On the third evening the official banquet of the Congress was held in the winter garden of the Grand Royal Hotel, and, like the preceding events, was a huge success. There were throughout

the week numerous lunches, drives, and entertainments for the visiting ladies by the local ladies' committee.

The Executive Work of the Congress.—This was undoubtedly the most outstanding feature of the Congress, the credit for which belongs to Professor Forssell and his splendid corps of associates, assistants, secretaries, and clerks. It is impossible to name all who were so vitally instrumental in the success of the Congress, but we must mention Dr. Heyman, Dr. Edling, Dr. Berwin, Dr. Ekerlund, and Dr. Renander, the latter being in particular evidence.

The Attendance.—Approximately eleven hundred individual members from over forty nations participated in the Congress, these countries having the largest representation being, in addition to Scandinavia, America, Germany, Russia, Italy, Great Britain, and France. The deliberations of the Congress were held in the French, German, and English languages.

The United States Delegation.—Several members of the American Committee were confused as to who really constituted the official United States delegation to the Congress. According to the last official communication, which the writer received from Sweden, the presidents of the recognized radiological and electrophysical bodies of the United States were officially appointed or elected to this high office. To this list had been added the name of Dr. Pirie, of Montreal. When the American Committee arrived at Stockholm they found that only three qualified delegates had registered, the other three not appearing at the Congress, and, as Dr. Pirie's name was printed in the Congress Register as an accredited Canadian delegate, the United States had really only two delegates, Dr. Skinner, for the Section on Radiology of the American Medical Association, and Dr. McFee, for the American Electro-therapeutic Society. This fact was brought to the attention of Presi-

dent Forssell by Dr. May, Dr. Ernst, Dr. Orndoff, and the writer, with the result that he at once authorized a full United States delegation, according to the by-laws of the Congress, as follows:

Dr. G. E. Pfahler, American Roentgen Ray Society

Dr. E. H. Skinner, Section on Radiology, American Medical Association

Dr. E. C. Ernst, Radiological Society of North America

Dr. B. H. Orndoff, American College of Radiology

Dr. Albert Soiland, American Radium Society

Dr. W. D. McFee, American Electro-therapeutic Society

These gentlemen were accordingly seated by unanimous vote of all the delegates of the Congress.

The writer suggests that in order to obviate such confusion as existed in the preparation of the American Committee and delegation for the Congress just concluded, delegates and alternates be elected from all recognized United States radiological bodies strictly in accordance with the constitution and by-laws of the International Congress as adopted in Stockholm.

ALBERT SOILAND, M.D.

REPORT FROM THE SECOND INTERNATIONAL CONGRESS OF RADIOLOGY, STOCKHOLM, JULY 23-27, 1928

The Second International Congress of Radiology met in Stockholm in July, under the presidency of Professor Gösta Forssell, Stockholm. There were 962 members partaking in the Congress, divided among 40 countries, of whom about 400 were also accompanied by ladies. The

members were divided among the different countries, as follows:

America	111
Argentina	5
Australia	1
Austria	17
Belgium	13
Brazil	2
Canada	11
China	1
Cuba	1
Czechoslovakia	24
Denmark	22
Egypt	1
England	81
Estonia	1
Finland	15
France	31
Germany	219
Greece	2
Holland	22
Hungary	11
Iceland	1
India	3
Italy	35
Japan	6
Java	1
Latvia	4
Mexico	1
Norway	13
Palestine	2
The Philippines	1
Poland	27
Porto Rico	1
Portugal	1
Roumania	13
Russia	83
Spain	16
Sweden	143
Switzerland	16
Tunis	1
Uruguay	3
<hr/>	
	962

The festival inauguration of the Congress took place in the beautiful Concert House in the presence of H.R.H. The Crown Prince and H.R.H. Prince Charles of Sweden. The President, Professor Gösta Forssell, opened the proceedings by a short speech in which he welcomed the guests, particularly directing himself to H.R.H. The Crown Prince, who had honored the Congress by his patronage. H.R.H. The Crown Prince then addressed the members and emphasized the gradually growing importance of radiology for the art of healing. The Chancellor of the Universities, Mr. E. Trygger, addressed the Congress on behalf of the universities, besides empha-

sizing the importance of radiology as an independent subject of teaching.

As a gift from the British Institute of Radiology, the President and Secretary-general of the First International Congress of Radiology, London, 1925, Mr. Thurstan Holland, representing Dr. S. Melville, handed over a presidential badge to Professor Forssell to be worn by the President of this and all future international congresses of radiology, after which Professor Gösta Forssell expressed his thanks in a short speech.

Mr. C. Thurstan Holland on behalf of the guests thanked H.R.H. The Crown Prince, the University Chancellor, and the Organizing Committee for the work they had done for the present congress. Papers were then read by teachers of radiology in different countries, with Professor Forssell introducing the subject of "Teaching and Training in Medical Radiology." The different speakers related their experiences and mentioned various objects to be desired. These papers will be published in book form, after the close of the Congress, as a supplement to *Acta Radiologica*.

Other proceedings of the Congress took place in Riksdagshuset (the House of Parliament) and were divided into sections for Roentgen Diagnostics, Roentgen and Radium Therapy, Radiobiology and Heliotherapy, Radiophysics and Medical Radiology. On special invitation six papers were read on chosen subjects by Balli (Italy—"Diagnostics Röntgen surtout au point de vue des organes de l'abdomen"), Holthusen (Germany—"Bestrahlung und Immunität"), Jaches (U. S. A.—"Lung Suppuration"), Knox (England—"The Rationale of Radiation Therapy"), Régaud (France—"Curiothérapie à distance"), and Reyn (Denmark—"The Combination of Local and General Light Treatment in Cases of Dermal Tuberculosis").

In the different sections altogether 225 papers were read, by subject as follows:

Roentgen Diagnostics.....	85
Roentgen and Radium Therapy.....	56
Radiobiology and Heliotherapy.....	40
Radiophysics and Medical Electrolgy....	44

In the section on *Roentgen Diagnostics* the papers dealt with the various aspects of that subject. Thus different parts of the digestive tract were made the subject of papers (the appearances of the mucous membrane of the ventricle, disease conditions and displacements of the small intestine and colon, the roentgen appearance in affections of the pancreas and in free and circumscribed exudations in the abdomen, etc.). The present position of roentgen diagnostics in diseases of the chest was elucidated by a number of papers on pulmonary tuberculosis, atelectasis due to different causes, pulmonary syphilis, thoracic cysts and other developmental disturbances. Several members gave the results of their investigations into the function and changes of the domes of the diaphragm. Cardiac disease and anomalies of the heart, besides investigations by the aid of densography and chymodensography, also attracted attention. A great number of papers dealt with modern methods of investigation by the aid of opaque injections into brain and spinal column for the diagnosis of tumors and other disease conditions of the central nervous system (encephalography and myelography), into female genital organs (hysterosalpingography), into kidneys (pyelography and pneumopyelography), as well as the use of contrast media in the examination of the accessory sinuses of the nose. Various disease conditions of the bony system (tumors, lues, internal secretory disturbances, anomalies, diseases of the joints, etc.) were also the subjects of numerous papers, besides which different technical subjects were dealt with (new methods of examination and technical nov-

elties, methods of localization by the aid of radiograms, stereoscopy, etc.).

In the section on *Roentgen and Radium Therapy* the chief interest centered around the technic of treatment and the results obtained in the treatment of malignant tumors, partly elucidated by statements of a general character, partly by case reports of tumors variously located. Stress was also laid on the importance of radiotherapy for inflammatory processes (in local superficial inflammations, in pneumonia, in diseases of the joints, asthma and affections of the tonsils). A number of papers also dealt with the roentgen treatment of nervous disease of different kinds, tuberculosis, goiter, and diseases of the skin. The organization, technic of treatment, and the results obtained at Radiumhemmet, in Stockholm, were dealt with in connection with a demonstration of about a hundred patients. An abstract of this, in the form of a pamphlet, was distributed among the members of the Congress (written by Professor Gösta Forssell, Dr. E. Berven, and Dr. J. Heyman). The demonstration roused great admiration, and speakers from different countries offered their congratulations on the results attained.

In the sectional proceedings on *Heliotherapy* questions were dealt with concerning the effect of light in different diseases, dosage in light treatment, theoretical subjects on the influence of ultra-violet rays on cells and tissues, on changes in the metabolism, and the results obtained by investigations into the therapeutic value of irradiated oils.

In the section on *Radiobiology* subjects were dealt with referring to the effect of roentgen and radium radiations on the blood, different organs and tissues, the effect of different wave lengths, etc.

In the section on *Radiophysics* there were read a great number of papers on various technical and theoretical subjects in connec-

tion with different sections of radiology. This section, furthermore, had two main themes on its working program, *viz.*, the establishment of an international unit of dosage in roentgen treatment and the question of how to obtain international regulations for protection in radiological work. Concerning the question of the international unit of dosage several discourses were delivered. Besides, the International Committee of the X-ray Unit discussed the question and agreed on a provisional unit called 1 Roentgen ("r"), corresponding to the German unit.

In order to solve the question of international regulations of protection an International Committee was constituted, which, with a few small alterations, resolved to advise the recommendations included in "Proposals from the British X-ray and Radium Protection Committee," previously sent out to all the members of the Congress.

During the Congress, the International Committee of Radiology met, there being delegates from 21 countries. At its first meeting, on July 23, this Committee appointed an Executive Committee with 7 members: Prof. G. Forssell, Mr. C. Thurstan Holland, Dr. A. Bêclère, Prof. W. Friedrich, Prof. M. Haudek, Dr. G. E. Pfahler, and Prof. P. Tandoja, in order to propose the place for the next Congress, based upon preliminary voting amongst the committee members, and to examine a proposal made by Prof. Gösta Forssell for statutes for the International Congresses of Radiology as well as to deal with questions of common interest. Paris was fixed as the place for the Third International Congress of Radiology, in 1931, and at the suggestion of the French delegates Dr. A. Bêclère was elected President by acclamation.

The above-mentioned proposal for the statutes for future International Congresses of Radiology was confirmed, and, in addition, it was resolved to appoint an Exec-

utive Committee in accordance with these statutes to be in force until the next Congress. The delegates who had acted as Executive Committee members during this Congress were elected as members of this committee. Regarding the suggestions made for the scientific working-program at the Third Congress of Radiology, as well as the questions of general interest referred to the International Committee at this Congress, it was resolved to submit these to the Third International Congress of Radiology.

An exhibition was arranged in connection with the Congress comprising apparatus, instruments, etc., of special interest to the members of the Congress (apparatus and utensils for roentgen diagnostics and roentgen therapy, for radium and light therapy, photographic material, opaque substances and chemical preparations, diathermal apparatus, etc.). The firms partaking in the exhibition numbered 45 (from Germany 24, England 7, France 1, Italy 2, Czechoslovakia 1, U. S. A. 1, Argentina 1, Austria 1, Belgium 1, Holland 1, and Sweden 5).

The proceedings of the Congress were concluded each day by festivities of different kinds. In the evening of July 23 a reception was arranged for all the members, about 1,400 persons being present. On July 24 Their Majesties The King and Queen of Sweden entertained the members of the Congress at tea at the Royal Palace, at which H.R.H. The Crown Prince on behalf of Their Majesties engaged himself in animated conversation with a great number of members. On Wednesday, July 25, the Corporation of the City of Stockholm gave a banquet and *soiré* at the beautiful Town Hall, and on Thursday, July 26, there was a subscription dinner at the Grand Hotel Royal in which 800 persons participated. In order to entertain the ladies several excursions were arranged within Stockholm and its environs during the dif-

ferent days, with visits to the museums and memorable buildings.

At the final session on July 27, the Congress resolved to approve of and promulgate the proposals of the X-ray Unit Committee for the ratification of the above-mentioned international unit of dosage in roentgen treatment, as well as the proposals for the international protection regulations. Furthermore, at the suggestion of the Executive Committee the Congress resolved to appoint a committee, which, until the next Congress, should deal with matters relating to the protective measures and kindred questions.

The President of the Congress, Professor G. Forssell, thereupon submitted a brief report of the work done by the Congress and conveyed the thanks of the Congress to the newly elected President, Dr. A. Bécclère. Dr. Bécclère conveyed the thanks of the Delegates to the Organizing Committee of the Second International Congress of Radiology, and expressed their gratitude for the hospitality displayed on the part of Sweden, with special reference to the Swedish Royal Family.

The Second International Congress of Radiology has now come to an end. Experiences in abundance have been exchanged between different countries, fresh impulses to continued research have been stirred up, and the ties between radiologists of the different countries have become still firmer united in a more intimate international co-operation. For all members of the Congress the days in Stockholm will surely remain a bright memory.

CLINICAL CONGRESS, BOSTON

The American College of Surgeons will hold the eighteenth Clinical Congress in Boston, October 8-12. Headquarters will be at the Statler Hotel and meetings will be held in the ballroom of the Copley-Plaza

Hotel and in Symphony Hall. The Hospital Standardization Conference will be held, in morning and afternoon sessions, in the ballroom of the Copley-Plaza Hotel Monday, Tuesday, Wednesday, and Thursday. An innovation this year will be the commencement of the clinics in the Boston hospitals on Monday afternoon, continuing through the mornings and afternoons of the following four days. Monday evening's program will include an address of welcome by the local Chairman, the address of the retiring President, Dr. George David Stewart, New York, the inaugural address of the new President, Dr. Franklin H. Martin, Chicago, and the John B. Murphy Oration on Surgery by Professor Vittorio Putti, of Bologna, Italy. Tuesday, Wednesday, and Thursday evenings' sessions will be held in the ballroom of the Copley-Plaza Hotel. At the Wednesday evening meeting the visiting surgeons will be the guests of the Boston Surgical Society at a special meeting, when the Bigelow Medal is to be awarded. On Friday evening the Annual Convocation of the College will be held in Symphony Hall, when the 1928 class of candidates for Fellowship in the College will be received. The Fellowship Address on this evening will be delivered by Dr. William J. Mayo. The annual meeting of the Governors and Fellows will be held Friday afternoon and will be followed by a symposium on Traumatic Surgery to be participated in by leaders in industry, labor, indemnity organizations, and the medical profession. Ether Day will be celebrated in the Dome Room of the Massachusetts General Hospital on Friday, upon which occasion a bronze bust of William T. A. Morton will be presented to the hospital. It was in this building that ether was first administered for the production of surgical anesthesia on October 16, 1846.

Several newly completed medical motion pictures, produced under the supervision of

the American College of Surgeons and approved by it, will be shown during the Congress.

Reduced fares on the railways of the United States and Canada have been authorized to those holding a convention certificate, so that the total fare for the round trip will be one and one-half the ordinary first class one-way fare.

Other outstanding features will be the exhibits. In addition to the commercial exhibits the departments of the College will present scientific exhibits.

A number of distinguished foreign guests of international reputation have signified their intention of attending. The Chairman of the Boston Committee on Arrangements is Dr. Frederic J. Cotton.

TESTS FOR ROENTGEN-RAY APPARATUS¹

Complaints have been received, from time to time, from medical department activities in tropical and subtropical countries that roentgen-ray apparatus does not function well during those seasons when relative humidity is high. In addition, the insulating material on some machines deteriorates rapidly. It seemed reasonable to suppose that the high moisture content of the atmosphere played an important part in producing the loss of radiation output and in the rapid breakdown of insulation. The problem was presented to the roentgen-ray laboratory at the supply depot for solution.

To determine the cause of these phenomena a special humidifying chamber was constructed, in which temperature and atmospheric moisture might be controlled. A complete, modern roentgen-ray outfit, with a Coolidge air-cooled therapy tube, was set up for test purposes. A Wulf Ionometer was

¹The paper from which this extract is taken by Dr. A. U. Desjardins was written by Dr. E. R. Stitt, Surgeon-General of the U. S. Navy. The author read it before the Annual Congress on Medical Education, Medical Licensure, and Hospitals, at Chicago, Feb. 6, 7, and 8, 1928.

used for measuring the radiation output. Normal atmospheric conditions, for test purposes, were fixed at 70 to 74°F. and 40 to 42 per cent relative humidity. Abnormal conditions, approximating those found in the tropics, were fixed at 82 to 85°F. and 81 to 83 per cent relative humidity. The machines under test were operated continuously for four-hour periods on several successive days. Various types of machines were tested and it was found that the maximum loss of radiation output, in any machine, when all parts of the machine were clean and free of dust, was 5 per cent. On the other hand, if dust were allowed to accumulate on the parts of the machine the loss of radiation output arose, in some cases, to 15 per cent.

The conclusions drawn from this experimental work are that a well-designed and well-built roentgen-ray machine, when kept clean and free of dust, will operate satisfactorily, with only a negligible loss of radiation output, when operated in an atmosphere with a relative humidity as high as 90 per cent. Navy specifications limit the allowable loss to 5 per cent.

Test work in connection with insulating materials for roentgen-ray use will be undertaken when time and facilities permit.

THE CHICAGO 1928 MEETING

SPECIAL RAILROAD RATES HAVE BEEN GRANTED

One and one-half fare for the round trip on the certificate plan from all points in the United States, and all points east of Winnipeg in Canada, for the coming meeting of the Radiological Society, in the Drake Hotel, December 3 to 7, inclusive, 1928.

Purchasers of tickets who are attending the meeting will secure a convention *certificate* when buying ticket to Chicago, pre-

sent that *certificate* when registering at the meeting, and, after the same has been validated, call for the *certificate*, which will be honored for one-half the railroad fare on the purchase of a return ticket, *via* the same route as going ticket. These rates hold good for all members of the families of those attending the meeting. Announcements will be made from time to time during the meeting relative to the validation of the certificates and their reclamation by the owners.

This meeting is going to be the largest of its kind ever held anywhere at any time, and those who plan attending it should make reservations for hotel accommodations immediately. The Drake Hotel, which is known as one of the best in this country, has made enormous concessions to our Society because of this meeting and we should crowd it to overflowing. Write to Dr. Frank J. Ronayne, West Suburban Hospital, Chicago, asking that he make reservation of such rooms as you will want. *Do it now.*

I. S. TROSTLER, M.D.
Transportation Manager.

THE SCIENTIFIC EXHIBIT

The purpose is to make this exhibit one of scientific value. With this in view, it is not enough that films and exhibits shall be of merit, but the explanatory labels should be prepared with care. It is most desirable that each exhibit shall be in charge of a demonstrator.

The committee is prepared to do its part in assuring the general attractiveness of the exhibit, having the rooms properly laid out, providing ample shadow-box facilities, furnishing uniform signs bearing the names of the exhibitors and titles of the exhibits.

Awards will be made on the basis of originality and excellence of presentation.

The committee will send application forms

to members at an early date. Dr. Robert A. Arens, Michael Reese Hospital, Chicago, is chairman.

"CHICAGO'S GREATEST RADIOLOGICAL SESSION"

This year's Annual Meeting of the Society—the Fourteenth—will convene on Monday, Dec. 3, and continue until Friday, Dec. 7, at the Drake Hotel, Chicago. The sessions, exhibits, and banquet will all be under the same roof, a plan which saves time and effort for those in attendance, and results in a concentration of interest.

However, many who come to the meeting will want to see something of the city, either to renew former impressions or to acquire new ones. With that in mind the Local Committee suggests the following as

among those points of interest not to be overlooked.

The American Medical Association Building is located at North Dearborn Street and Grand Avenue, about a mile from the Drake Hotel. Visitors will be shown over this most interesting establishment and acquainted with the various ways in which the Association stands ready to be of service to its members.

The Northwestern University Medical and Dental Schools (also the schools of Law and Commerce) are grouped about McKinnock Campus, on the lake front some half-dozen blocks from the hotel. The Loyola University Medical School is located at Loyola Avenue and Sheridan Road and may be readily reached by motor bus or elevated. The University of Illinois School of Medicine is adjacent to the Cook County Hospital, which, incidentally, is one of the world's



Reception Court, Drake Hotel, Chicago, headquarters of the Fourteenth Annual Meeting of the Society.

largest hospitals. The new Children's Hospital, one of its divisions, is well worth a visit. Close by is Rush Medical College. The new Billings Hospital is part of the University of Chicago group, on the South Side. The fine Gothic architecture of the University buildings and the natural beauties of the campus will well repay one for a visit. It may be reached by motor bus from the hotel.

Also on the South Side but near the Loop is the new Grant Park development on the lake front. Here is located Soldiers' Field, a tremendous amphitheatre of reinforced concrete and steel, in which more than 110,000 gathered for the Army and Navy Football Game. University football is played here during each season.

Adjacent to the stadium is the Field Museum of Natural History, one of the world's finest museums. There are many Akeley animal groups here, reproducing in fascinating detail the natural habitat of each animal; there are reconstructed pueblos; scenes from tribal ceremonies, and marvelous collections from Polynesia. The Gem Room alone will hold one enthralled for hours.

The Art Institute is also located in Grant Park, on Michigan Avenue, practically within the Loop. Here are found a splendid collection of paintings by the world's most celebrated artists, etchings, rare tapestries, antiques of artistic value—all housed in a splendid structure.

The Senn Room of Medical Sciences is a part of the John Crerar Library, at Michigan Avenue and Randolph Street. Since this is one of the largest and most completely catalogued collections of medical reference works in the country, visiting physicians may desire to acquaint themselves with the opportunities it offers for study.

Hull House, made famous by Jane Addams, is a Mecca for Chicago's distinguished visitors. It is located at Polk and

Halsted Streets. There are many other settlement houses and vocational societies scattered throughout the foreign districts of the city, to which visitors will be directed upon inquiry.

The opera season will be open at the time of the meeting, so that visitors may avail themselves of this musical delight. The theatrical season will be at its height, too, and there will be many plays from which to choose. Tickets may be purchased at the news stand in the hotel. There are many fine motion picture theatres to be reached readily from the Loop or the hotel.

The motor buses give universal transfers, so that one may ride from the hotel to the south, north, or west limits of the city for a ten-cent fare. The Northwestern University at Evanston may be easily reached by the elevated railroad.

Visitors to Chicago are invariably questioned as to whether they visited the Stock Yards, the vastness and marvels of which have been widely described. Guides are furnished at the entrance of the Yards, and one may or may not view the killing, as desired.

The Loop is rich in shops, many of them of country-wide reputation. There is a district of specialty shops surrounding the hotel, also, for those who do not find the time to go far from the headquarters. The Registration Desk will have a personnel prepared to answer any question in the way of directing visitors.

The Municipal Airport covers 320 acres between South Cicero and South Center Avenues and West 59th and West 63d Streets. Six hangars have already been erected. The air mail leaves at 9:30 every evening, and its take-off is witnessed by many.

These suggestions may serve to remind members of the Society that their families will enjoy accompanying them to the Chicago meeting in December.

ABSTRACTS OF CURRENT LITERATURE

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Death during a Roentgen-ray Treatment Because of Lung Embolism. E. Saupé. *Strahlentherapie*, 1928, XXVIII, 624.

The case of a patient suffering from Hodgkin's disease who died suddenly during a roentgen-ray treatment is reported. Because of shortness of breath, the patient had to be treated while seated on a chair; during the latter part of the treatment, he dropped forward, and, before the technician could turn off the current, a spark went across from the negative pole to the head of the patient. The autopsy revealed, however, an embolism in the left lower lobe of the lung; this was undoubtedly the primary cause of death.

E. A. POHLE, M.D.

Intermittent Duodenal Stenosis. Richard Hayes and Arthur B. Shaw. *Northwest Med.*, January, 1928, p. 6.

This is a very excellent presentation of a condition which has not been given its due merit of attention. Chronic duodenal stenosis admits of division into three types: (1) That of the bulb; (2) that of the second and third portion, due to bands; (3) duodenal arterio-mesenteric ileus due to mesenteric drag. It is the latter two types of which the authors write, the so-called periodical "bilious attacks," with the typical migraine symptom-complex. The roentgenologic examination is the most important factor, and the technic of this is quite important. The most important point in technic is that the patient must be examined *during the attack*, else the findings are very likely to be negative, and a diagnosis of cholecystitis, gastric or duodenal ulcer, appendicitis or gastric neurosis, be made. Thirty-eight cases are reported, in which complete X-ray examinations have been made, repeatedly on most of them. The radiographic reproductions show the intermittent dilatation of the duodenum, and illustrate how the findings will be negative unless made at the proper time.

W. WARNER WATKINS, M.D.

Diverticula of the Thoracic Esophagus. Lester A. Smith. *Am. Jour. Roentgenol. and Rad. Ther.*, January, 1928, XIX, 27.

The author gives a complete summary of cases reported in the literature of diverticula of the thoracic esophagus, recognized antemortem, and notes that most cases reported were found in the lower third and only one case of multiple sacculations was previously reported. Nine new cases are reported, four of which showed multiple sacculations. While some intimation of the presence of a diverticulum was obtained in every case with the patient in the left anterior erect position, the horizontal or Trendelenburg position is recommended to show the pathology best. Only three of the nine cases presented symptoms

referable to the diverticulum. Dysphagia, regurgitation, and a sensation of food lodged at the level of outpouching of the esophageal wall were the symptoms noted. The patients' ages varied from 41 to 78, the average being 60. Smith agrees with Carman and others that congenital weakness of the esophageal wall is the most important factor in the production of a diverticulum.

J. E. HABBE, M.D.

Radium Treatment in Carcinoma of the Mouth and Tongue. G. E. Birkett. *Lancet*, May 12, 1928, CCXIV, No. 5463, p. 953.

During the author's first year at the Radium Institute, 127 out of 565 cases of malignant disease referred for treatment had carcinoma of the mouth and tongue. At the end of this year 16 per cent of these patients were free from evidence of disease, but later examination showed that the results were sporadic and that the reaction of the radium treatment had been very severe. Glass radon seeds had been used. All the cases were frankly inoperable and about 50 per cent were in the last stages of the disease. When the records over a period of ten years were examined it was found that 51 out of a total of 812 cases were well for periods of time varying from one to nine years and practically all of these cases were surgical rejects. Eighty per cent were treated by burying unscreened radon seeds in the primary growth. The tube strength varied from 10 to 12 millicuries per linear centimeter and the screening from 0.3 mm. of brass to 0.3 mm. of platinum.

Following Régaud's report the author changed the technic as follows: The containers were 16 mm. in length with a wall thickness of 0.2 mm. of platinum, containing 1 mg. and 2 mg. of radium element each. These containers were placed in platinum needles with a wall thickness of 0.4 mm., giving a total screening of 0.6 mm. of platinum. They were implanted for an average time of from 8 to 10 days, although as long as 14 days has been given. Where radon was employed instead of the radium element an initial strength of 2 to 2.9 mc. for the same size tube was adopted. The author prefers radium

element to emanation, and discusses its advantages. He believes a constant radiation more useful than a decreasing one and thinks there is less risk of tissue necrosis. As far as possible, tubes are implanted in the growing edge of the tumor and where the lesion is very large they are also buried in the tumor itself. They are placed about one centimeter apart.

Broadly speaking, metastases from the floor of the mouth and the anterior third of the tongue will be in the sub-mental, sub-maxillary, and upper deep cervical groups of glands; from the fauces, tonsil, and middle third of the tongue in the sub-maxillary and upper and lower deep cervical groups, and from the base of the tongue in the upper and lower deep cervical groups. When a lesion has crossed the mid-line, infection of one or both sides can occur. As a satisfactory technic has not yet been developed for external applications which would cover the whole of the lymphatic drainage area on both sides of the neck, the following method of treating the gland-bearing area has been adopted.

A careful system of examination at monthly intervals is made and if glandular enlargement occurs a bloc dissection, combined with implantation of radium, is carried out. In a few cases in which the primary growth has resolved and in which the glands have been too fixed for surgical removal, implantation has been resorted to, with comparatively good results. The bloc dissections carried out are thorough and include the removal of the internal jugular vein and the sternomastoid muscles. When the operation is completed, 8 to 12 tubes, containing about 6 mc. of radium emanation and screened by 0.8 mm. of platinum, are implanted in the wound, concentration being directed usually to the area deep to the parotid and angle of the jaw and to whichever gland-bearing area is most likely to be affected. Silk threads attached to the tubes are brought out at the lower end of the incision and act as drains. The tubes are removed in from three to four days' time. The primary lesion has invariably been dealt with in the first place.

The author believes it more reasonable to

treat the primary lesion first so as to remove foci of infection and what must always be a source of malignant emboli.

Ninety-seven per cent of cases of carcinoma of the mouth and tongue were seen in men. Any form of ulceration in the mouth, lasting for more than a week or two, in a patient over thirty years of age should arouse a strong suspicion of malignancy. Of course, syphilis must be ruled out. The author condemns biopsy whole-heartedly as he believes it tends to accelerate local growth and to favor metastases.

To the criticism that one should hesitate to perform bloc dissection unless the exact nature of the primary lesion is known, he replies that the majority of patients are elderly and that, unless palpable glands are present, a conservative and expectant attitude is usually adopted. The persistence of palpable glands after the disappearance of the primary lesion is sufficient ground for the surgical operation, and these glands usually afford positive evidence of malignancy. His argument for the use of two divergent methods of treatment for the same condition, *viz.*, radium for the primary lesion and surgery plus radium for the lymphatic area, is that by virtue of its position, cancer of the mouth is rarely capable of wide excision. On the other hand, metastasis occurs along a system, so to speak, of pipes and cisterns. Before the walls of this system have been invaded, it should be an ideal field for surgical treatment, so long as spread is embolic and not by permeation.

The author discusses the histology of oral cancers and then lists them clinically as follows: (a) those involving the tip and anterior third of the tongue; (b) those arising at the base of the tonsil, tending to involve the middle third of the tongue and spreading to the tonsil and fauces and floor of the mouth; (c) those involving the base of the tongue. Of 76 cases in which the tongue was involved and treated, 14 were in Class A, 52 in Class B, and 10 in Class C. The reaction following the use of heavily filtered radium has been negligible. The greater problem is to carry what amounts to a pin-cushion in the mouth for a week or more. There has been profuse

hemorrhage in two instances, but it occasioned no anxiety—he believes it was probably due to ulceration into the lingual artery.

In the following table are shown the results on the primary lesion.

	Well	Total	Percentage
			Well
Tongue	34	75	46.66
Fauces and tonsil.....	10	36	27.77
Floor of mouth.....	14	42	33.33
Hard and soft palates	11	36	30.50
Cheek and lip.....	11	26	42.0

An analysis of the 1926 results showed that 40.8 per cent of those cases in which the radium implants were left for seven or more days were well, compared with 22.8 per cent of those treated for less than seven days. The author, therefore, considers that with the implants in use seven days has been the aim in subsequent cases. Eighty cases were treated during 1926 and of these, 27.5 per cent are well. In 38.75 per cent the primary lesion resolved. In 36.25 per cent there has been no evidence of recurrence at the primary site. Seventy-four cases were treated during 1927. Of these, 35 per cent show no signs of local or metastatic disease. In 45.9 per cent the primary lesion has resolved.

This article is worth reading, but if the author will report these cases at three- and five-year periods, the effect of his technic can be better evaluated.

H. J. ULLMANN, M.D.

The Normal Kidney Pelvis. Hugh James Polkey. Urologic and Cutaneous Review, June, 1927, XXXI, 339.

The average normal renal pelvis has many characteristic features, all of which are capable of considerable variation in morphology. Bilaterally the pelves are similar in both form and capacity, though not equal. The physiologic and anatomic capacities of the pelvis have normal averages, though variations are frequent. The average physiologic capacity is about 8 c.c., this figure varying with different investigators; the average anatomic capacity is about 12 c.c. The normal emptying

time of the pelvis should be about three to ten minutes.

The normal pelvis has a characteristic shape and is capable of being divided into types, the most common of which are as follows: (a) the extreme ramified type without a definite pelvis; (b) the ramified type with well formed pelvis and calyces (the most frequent type); (c) the ramified type with the hemipelvis of Hyrtl (with a large inferior major calyx); (d) the ampullary type (with minor calyces but no major calyces).

The types are directly the result of development, especially of the embryological process of reduction, and indirectly of heredity and environment.

ROBERT A. ARENS, M.D.

Experience in the Treatment of Brain Tumors by Irradiation during the Past Thirteen Years. Henry K. Pancoast. *Am. Jour. Roentgenol. and Rad. Ther.*, January, 1928, XIX, 1.

In this article the results of irradiation treatment of 48 cerebellar tumors are given. Twelve tumors were either partly or completely removed surgically prior to radiation; eighteen were located surgically but not removed, and of the eighteen remaining cases in the series seventeen were surgically explored but the tumor was not found. Twenty-five of these patients lived for periods varying from a few months to thirteen years. The author's factors are: 200 K.V., 0.5 mm. Cu. plus 2.0 mm. Al., 50 cm. target skin distance, 300 ma.-min. to each of three 6 cm. \times 8 cm. portals, but never more than 60 ma.-min. are given on one day. It is felt that if

at operation a tumor is found which cannot be removed, a biopsy only should be done. After histological study, such tumors as will not respond to external irradiation only, might be submitted to a second stage implantation. By this plan the hasty introduction of radium emanation into normal brain tissue, with possible fatal results, would be avoided. The writer believes cerebellar tumors to be more responsive to radiation treatment than cerebral tumors, and pleads for an attempt at operative localization in every case of probable brain tumor before submitting the case to X-ray therapy.

J. E. HABBE, M.D.

The Dosage with the Sabouraud Tablet from the Viewpoint of the Half Value Layer in Aluminum. V. Wucherpfennig. *Strahlentherapie*, 1927, XXVII, 353.

The Sabouraud Tablet is still widely used in superficial therapy. In order to study its reliability, the author measured the output of thirty-five Coolidge tubes. In each case, the half value layer in aluminum was recorded first (82 K.V., 4 ma.). It appeared that the thickness of the glass wall of the tubes differed greatly; in the extreme, its filter effect equaled that of 0.5 mm. aluminum. The tube characteristics were also quite variable. Inasmuch as the Sabouraud Tablet is quite dependent upon the wave length, it is suggested to always measure the quality of the radiation before comparing the quantities. The half value layer in aluminum is recommended for that purpose.

E. A. POHLE, M.D.

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